Kentucky

Agricultural Experiment Station

University of Kentucky

REPORT ON SOIL EXPERIMENT FIELDS

BULLETIN NO. 322

Lexington, Ky.

September, 1931

EXPERIMENT STATION STAFF

BOARD OF CONTROL

Richard C. Stoll, Chairman, Lexington, Ky.
R. G. Gordon, Louisville, Ky.
James Park, Lexington, Ky.
James W. Turner, Paintsville, Ky.
E. B. Webb, Lexington, Ky.

Frank L. McVey, President — Thomas P. Cooper, Dean and Director

ADMINISTRATION

T. P. Cooper, Director
D. H. Peak, Business Agent
O. L. Ginocchio, Secretary

AGRONOMY

George Roberts, Head
E. J. Kinney, Assoc. Agronomist
P. E. Karraker, Asst. Agronomist
J. F. Freeman, Asst. Agronomist
W. D. Valleau, Plant Pathologist
E. N. Fergus, Asst. Agronomist
J. B. Kelley, Agricultural Engineer
E. M. Johnson, Asst. Plant Pathologist

ANIMAL HUSBANDRY GROUP

E. S. Good, Chairman
W. S. Anderson, Horses
E. J. Wilford, Swine, Meats
W. J. Harris, Beef Cattle
J. Holmes Martin, Poultry
C. J. Maupin, Poultry Improvement
Fordyce Ely, Dairy Husbandry
W. C. Eskew, Cream Grading
Wesley Brooks, Cream Grading
J. W. Nutter, Dairyman
Amanda Harms, Asst. Path. Bact.
G. D. Buckner, Animal Nutrition
W. M. Insko, Jr., Animal Nutrition
Harold Barber, Head Herdsman

ANIMAL PATHOLOGY

W. W. Dimock, Head
Philip R. Edwards, Bacteriologist
F. E. Hull, Asst. Veterinarian
D. J. Healy, Bacteriologist
Genevieve Farwell, Technician

CHEMISTRY

J. S. McHargue, Acting Head
S. D. Averitt, Chemist
O. M. Shedd, Chemist
W. R. Roy, Asst. Chemist
Robert Calfee, Asst. Chemist
Jos. G. Pelphrey, Asst. Chemist

CREAMERY LICENSE SECTION

J. D. Foster, Inspector, in Charge
N. J. Howard, Inspector

ENTOMOLOGY AND BOTANY

W. A. Price, Head
Mary L. Didlake, Asst. Entomologist
H. H. Jewett, Research Asst. Entgst.
C. O. Eddy, Assoc. Entomologist
Jessie Taylor, Seed Analyst

FARM ECONOMICS

W. D. Nicholls, Head
W. L. Rouse, Farm Management
Merton Oyler, Rural Life Studies
George B. Byers, Farm Organization
Bruce Poundstone, Farm Management

FEED CONTROL

J. D. Turner, Head
H. D. Spears, Chemist
W. G. Terrell, Inspector
Fred Fitschen, Inspector
Encil Deen, Inspector
L. V. Amburgey, Microscopist

FERTILIZER CONTROL

H. E. Curtis, Head
Harry Allen, Chemist
Lelah Gault, Asst. Chemist
Robert Mathews, Inspector

HOME ECONOMICS

Statie Erikson, Head
Ruth Boyden, Assistant

HORTICULTURE

A. J. Olney, Head
C. S. Waltman, Assistant
E. M. Emmert, Assistant

MARKETS AND RURAL FINANCE

H. B. Price, Head
Dana G. Card, Prices
Clifton Bradley, Rural Finance
C. D. Phillips, Markets
Olin M. Farrington, Markets

PUBLIC SERVICE LABORATORY

L. A. Brown, Head
A. L. Meader, Asst. Chemist
James H. Martin, Asst. Chemist
E. K. Borman, Bacteriologist
W. B. Hamilton, Asst. Bacteriologist
Harvey Cunov, Asst. Bacteriologist
Todd Green, Asst. Bacteriologist

ROBINSON SUBSTATION
(Quicksand, Ky.)

R. W. Jones, Superintendent
James S. Kring, Forest Ranger

WESTERN KY. SUBSTATION
(Princeton, Ky.)

S. J. Lowry, Superintendent
L. M. Caldwell, Assistant

CONTENTS

Introduction. Page

General Plan of Experiment Fields 357

Method of Computing Crop Increases 357

Fertilizing Materials Used 359

Method of Reporting Crop Yields 359

Crop and Fertilizer Values 361

Report of Results.

The Berea Field 362

The Fariston Field 366

The Campbellsville Field 372

The Greenville Field 386

The Mayfield Field 397

The Lone Oak Field 409

The Hopkinsville Field 410

Recommendations 410

Series 100	Series 200	Series 300	Series 400
101 M	201 M	301 M	401 M
102 None	202 None	302 None	402 None
103 ML	203 ML	303 ML	403 ML
104 M	204 M	304 M	404 M
105 MP	205 MP	305 MP	405 MP
106 MRP	206 MRP	306 MRP	406 MRP
107 M	207 M	307 M	407 M
108 MPK	208 MPK	308 MPK	408 MPK
109 MRPK	209 MRPK	309 MRPK	409 MRPK
110 M	210 M	310 M	410 M
111 MLP	211 MLP	311 MLP	411 MLP
112 MLRP	212 MLRP	312 MLRP	412 MLRP
113 M	213 M	313 M	413 M
114 MLPK	214 MLPK	314 MLPK	414 MLPK
115 MLRPK	215 MLRPK	315 MLRPK	415 MLRPK
116 M	216 M	316 M	416 M

M = manure; L = limestone; P = superphosphate; RP = rock phosphate; K = potash.

BULLETIN NO. 322

Report on Soil Experiment Fields*

By GEO. ROBERTS and J. F. FREEMAN

GENERAL PLAN OF EXPERIMENT FIELDS

The accompanying diagram shows the general plan of the experiment fields reported in this bulletin. Four series of plots are represented, identical in soil treatment. This plan accommodates a four-year rotation. If, for example, the rotation is corn, soybeans, wheat and clover, and corn should appear on Series 100, then clover would appear on Series 200, wheat on Series 300, and soybeans on Series 400. The next year, corn, clover and wheat would each move to the right one series, and soybeans would appear on Series 100. A three-year rotation would require three series of plots.

In the illustration the purpose is to determine the effect, upon crop production, of limestone, superphosphate, rock phosphate and potash on soil where legumes are grown in the rotation and manure is used in quantities produced by feeding the crops grown. The check plots (Nos. 1, 4, 7, etc.) receive considerably less manure than the fertilized plots that produce more crops.

The plots used in the experiments reported in this bulletin range in size from one tenth to one twentieth acre, most of them being of the larger size.

METHOD OF COMPUTING CROP INCREASES

It is practically impossible to find an area of soil of uniform productivity large enough for an experiment field; in fact it is rare that two adjoining plots have the same productivity. On

* The soil fertility investigations upon the outlying experiment fields of the Kentucky Experiment Station, from the time of their establishment thru 1930, are reported upon in this bulletin. Work of a similar nature is being done upon the Experiment Station farm at Lexington, but the soils of this farm are so different from those of the outlying fields that it was thought best to publish the results in a separate bulletin to appear later. Soil management investigations are conducted also at the Western Kentucky Substation at Princeton, but they have not been in progress long enough to warrant the publication of results.

account of lack of uniformity in soil, the use of check plots is necessary to measure crop increases on various parts of the field. Check plots should be distributed at frequent intervals thruout a series of plots. On the older fields, too few check plots were used, because their importance was not fully appreciated at the time the fields were established.

Increases in yield due to various treatments are calculated by comparison with the check plots. In this report, where the number and location of check plots made it advisable, the crop increases were computed upon the assumption that the soil varies uniformly from one check plot to another. This method may be illustrated by the following example:

Plot No.	Treatment	Yield of Corn Per Acre	Increase
1	None (check plot)	30 bushels	.....
2	Superphosphate	38 bushels (–31)	7 bushels
3	Limestone and superphosphate	45 bushels (–32)	13 bushels
4	None (check plot)	33 bushels	.....

Upon the assumption of a uniform variation in the soil between the two check plots, plot No. 2, if untreated, would have yielded 31 bushels per acre, and plot No. 3, 32 bushels per acre. Substracting assumed yields from the respective yields of the treated plots, gives increases of 7 bushels and 13 bushels. While absolutely uniform variation does not often occur, this seems, on the whole, to be the most satisfactory method of computing increases. However, other methods may be used. The increase may be calculated by subtracting from the yield of a treated plot that of the nearest check; or the average yield of two checks between which a treated plot lies may be substracted from that of the treated plot. Two adjacent plots differing in treatment by a single element may be compared directly, without reference to a check plot.

If there is not substantial agreement in increases computed by all these methods, the results may be considered unreliable because of soil variation. To be considered significant, the increase or decrease in yield of a treated plot should be greater than the difference in yield of the check plots between which the treated plot lies.

In the experiments reported in this bulletin, manure, where used, was applied on both check plots and fertilized plots; therefore the calculated increases are accredited to the limestone and fertilizers used on the treated plots. If check plots are not treated in any way, they may reach such a low state of productivity as to give an exaggerated importance to soil treatments when measured by crop increases. In such cases there may be a large increase due to fertilizer treatment when the total production does not cover the cost of production.

FERTILIZING MATERIALS USED

Unless otherwise specified, the following grades of fertilizing materials were used:

Superphosphate containing 16 percent "available" phosphoric acid.

Rock phosphate containing approximately 30 percent total phosphoric acid and guaranteed ground sufficiently fine for 90 to 95 percent to pass thru a 100-mesh screen. Rock phosphate was used at twice the rate of superphosphate, for the reason that when the work was begun these rates represented approximately equal cost per acre.

Potash salts, muriate or sulfate, containing approximately 50 percent potash (K_2O), except that for a short time during and following the war potassium carbonate was substituted.

Commercial nitrate of soda, containing approximately 15.5 percent nitrogen.

The manure used was purchased from miscellaneous sources, much of it from livery stables, and very probably was not so good as could have been produced by feeding the crops grown on the field, which contained a large proportion of legumes. It is not feasible to keep livestock at those small fields for the purpose of producing manure. The manure was thoroly mixed before application to the plots.

METHOD OF REPORTING CROP YIELDS

Crop yields generally are presented as averages for the first half and second half of the time during which the field has been in operation. When the number of crops is odd, the second period includes the extra crop. Crop failures are indicated but

are not counted in the averages. Sometimes substitute crops were grown for harvest, but not always, because it was desired not to interrupt the regular rotation. However, in farm practice the use of substitute crops would be the logical procedure.

The yields are all on the basis of field-cured crops, as facilities were not available for making accurate moisture determinations. Seventy pounds of ear corn are allowed to the bushel. Efforts were always made to have crops as well cured as conditions would permit. Soybeans are difficult to cure and frequently are harvested late, when weather for curing is unfavorable; consequently the soybean hay contained more moisture than the clover hay.

The actual differences in hay yields on the plots so treated as to produce good clover and the other treated plots and check plots that did not produce good clover were greater than the yield figures indicate, because where the clover was poor there was a larger content of weeds and wild grasses. This is especially true of the first period, when clover alone was used most of the time.

Plots treated with limestone and phosphate usually have produced good clover, while plots without these treatments and the check plots often have produced low yields or none. The growth of a legume greatly influences the yield of non-leguminous crops in the rotation. It seemed poor practice to continue to use only clover which was sure to fail on many plots and to make poor growth on others, for to do so would give exaggerated importance to those soil treatments that produce good clover. It was decided to use a mixture of legumes and grasses for hay, and in the report on each field a statement is made of the additions made to the mixture from time to time. One object in using a mixture was to find a legume that would grow well with soil treatments with which clover generally fails. Such a legume would be of material advantage in improving the productivity of these plots. In farm practice, crop plants would be used that would produce pasture and hay under the existing conditions.

Some valuable information is being accumulated, as will be seen in the data from the various fields. For example, lespedeza makes a good growth on many plots on which red clover fails, while it is largely choked out on those plots on which red clover

does well. It has been found, also, that alfalfa in the mixture grows well on limed plots after the main hay crop has been harvested, giving a good second crop in some instances. The grass is an advantage on the plots on which clover and alfalfa will not grow. Often when lespedeza does not get high enough to cut it produces a dense growth which is valuable in protecting the soil from erosion and in adding nitrogen to the soil. Some plants in the mixture are more resistant to drouth than others.

Even under favorable soil conditions for clover, the use of a mixture of plants for hay is considered good practice, for sometimes other than soil conditions cause a failure of clover when lespedeza or alfalfa, for example, persist (see Campbellsville field).

The drouth of 1930 was the worst in a period of about seventy-five years; consequently the crop yields for this year, with a few exceptions, are poor or almost failures. Corn being practically a failure on all the fields, the yields are not included in the averages because they do not give a true measure of the effect of the various treatments, and to include them would give misleading results. Often variation in moisture affected yields more than variation in soil treatment. Check plots sometimes yielded more than treated plots that normally yielded very much more than the checks.

CROP AND FERTILIZER VALUES

No money values of soil treatments are stated in this report. Costs of limestone, fertilizers and crops vary greatly in different places and at different times. It seems better for those interested in net money values of crop increases to make their own calculations based upon local prices. The most profitable treatments are evident without such calculations. For the benefit of those who wish to make such calculations, the average yearly applications of fertilizers and limestone are given or clearly implied. Our opinion is that in most instances more limestone has been used than was necessary and that in the tobacco rotations the amounts were so large as to be harmful. Because of the excessive use of limestone, costs of treatments will in many instances be higher than necessary. It is highly probable that a two-ton application is sufficient for eight to ten years on most

soils of the state, for they are not, as a rule, strongly acid. Soils represented by the Berea field probably will respond profitably to as much limestone as has been used on this field.

BEREA SOIL EXPERIMENT FIELD

H. H. Harrison, Berea College, In Charge

The Berea soil experiment field is conducted in cooperation with Berea College, on land belonging to Berea College. It is located in Madison County, about two miles east of Berea, on a soil type designated by the United States Bureau of Soils as DeKalb silt loam. Similar soils are found at the base of the chain of knobs surrounding the Bluegrass region. These soils are of a light color, generally quite acid, low in phosphorus and nitrogen, and poorly drained where the land is level or nearly so. An analysis of a sample of surface soil from this field gave the following results, stated as pounds in 2,000,000 pounds of soil (the weight of an acre to the depth of about 7 inches):

Total nitrogen	2,200 lbs. per acre
Total phosphorus	880 lbs. per acre
Total potassium	19,000 lbs. per acre

The surface soil is strongly acid (pH 4.5), while the subsoil is more so.

Work was begun on this field in 1913. A rotation of corn (rye cover crop), soybeans, wheat and clover was tried at first, but the soil was so poorly drained that wheat and clover either failed or made very poor growth.

In the spring of 1917 the field was tile-drained, and the four-year rotation of corn, soybeans, wheat and clover was tried again, but wheat made such poor yields that, after four years, rye was substituted. Clover and grass were sown on the rye, and the rye cut before maturity, since pasturing could not be practiced on experimental plots as is done in farm practice. The clippings were removed if too heavy, but frequently were left on the ground.

Limestone was used twice, at the rate of 2 tons per acre, between 1913 and 1921. It was applied on the broken corn ground. In addition to this, in 1913, fractional applications were made in the other series as follows: Series 200 had a one-fourth application; Series 300, a half application; and Series

400, a three-fourths application. No more limestone was used until 1928. Betwen 1928 and 1930 the limed plots in each series received another application at the rate of 1 ton per acre.

Superphosphate was used at the rate of 800 pounds per acre on the corn ground for two rounds of the rotation, with fractional applications in the beginning as with limestone. Rock phosphate was used in the same way but at twice the rate of superphosphate. After two rounds of the rotation, the rates were reduced one half.

Muriate of potash, or its potash equivalent, was used at the rate of 400 pounds per acre on the corn ground for three years, with fractional applications the first year as in the case of the other materials. Since that time the rate has been 200 pounds per acre.

The fertilizers were applied broadcast on the broken ground and disked in, except that rock phosphate was applied before breaking about half of the time.

Manure was used on the corn ground at the rate of 6 tons per acre on all plots except No. 1, from 1917 to 1921. Since then it has been applied on each manured plot on the corn ground at a rate equal to the weight of the three crops removed from the corresponding plots the previous year, except in 1927-28, when the amount returned to each plot was equal to the weight of the crops removed from the check plots the preceding year. In the eighteen years, four cowpea crops have been turned under preceding the corn crop, when the clover crop failed or was poor.

The total applications of limestone and the various fertilizing materials are equivalent to annual applications of approximately the following amounts:

Limestone	640 lbs.
Superphosphate	160 lbs.
Rock phosphate	320 lbs.
Muriate of potash	65 lbs.

The crop yields for the various fertilizer treatments are given in Table 1. The corn crop of 1930 is not included on account of low yields due to drouth. The soybean crop of 1913 is missing from the averages because workmen misunderstood instructions to harvest by plots. The crop of 1930 was so poor

Table 1. Crop Yields Per Acre, Berea Soil Experiment Field.

Serial Plot No.	Treatment*	Corn, Bus., Ave. 17 Crops				Soybean Hay, Lbs., Ave. 17 Crops				Clover Hay, Ave. 12 Crops			
		First Period	Second Period	Both Periods	Increase† Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment
1	None	17.8	10.7	14.0	...	1840	1814	1826	...	88	407	248	...
2	ML	36.4	42.4	39.6	11.1	3368	3658	3521	695	665	1113	889	324
3	M	28.5	28.6	28.5	14.5	2623	3007	2826	1000	343	787	565	317
4	MP	33.0	45.1	39.4	10.9	3336	3761	3561	735	607	1642	1124	559
5	MRP	31.7	46.3	39.4	10.9	3192	3651	3435	609	603	2212	1408	843
6	MLP	38.7	51.5	45.5	18.7	4133	4531	4344	1318	1892	2993	2442	1809
7	MLRP	39.7	49.8	45.1	18.3	4113	4492	4314	1288	1688	3122	2405	1772
8	M	24.3	29.1	26.8	...	2657	3353	3026	...	280	987	633	...
9	MLPK	43.4	51.8	47.9	21.1	4408	5004	4724	1698	1860	3458	2659	2026
10	MLRPK	36.2	52.3	44.7	17.9	3606	4516	4087	1061	1518	3180	2349	1716

* L = limestone; P = superphosphate; RP = rock phosphate; K = muriate of potash; M = manure.

† Increases for manure were obtained by subtracting the yield of Plot 1 from that of Plot 3. Manure was used on 4 corn crops (1917-20) in the first period and on all of them (9) in the second period. Increases for limestone and fertilizer treatments were obtained by using the nearest manured plot as a check (Plot 3 or 8).

that it reduced the average of the seventeen-year period by about 150 pounds. The first clover crop was not obtained until 1918, because of conditions previously mentioned. The clover crop for harvest in 1923 did not survive the winter. Cowpeas were grown in its place and disked in, followed by a rye cover crop.

Since 1926, timothy and common lespedeza were sown with the clover—a mixture of red and alsike—and in 1928 redtop and Korean lespedeza were added. In 1927, 1928 and 1929, small amounts of alfalfa and sweet clover were included on one half of each plot, and in 1930 they were included on the whole of the plots. Alfalfa and sweet clover made a fair growth on the plots treated with limestone and phosphates and were somewhat better where potash was included. In years unfavorable for clover a large proportion of the hay has been grass.

In most years lespedeza reseeded itself the first year and made a fair to good stand on those plots (unlimed) which did not produce a good growth of other clovers and grasses. On the limed plots the lespedeza was largely choked out. The following plots produced lespedeza high enough to cut after removing the regular hay crops in 1927.

Plot No.	Treatment	Hay Lbs. Per Acre
1	None	70
2	ML	870
3	M	1140
4	MP	3330
8	M	1430

DISCUSSION OF RESULTS

The outstanding requirements of this soil for mineral fertilizers are lime and phosphate. When all three crops are considered, the yields are practically identical for superphosphate and rock phosphate when used without limestone (Plots 4 and 5). The same is true where limestone was used (Plots 6 and 7). The small differences are no greater than differences commonly caused by soil variation. Where both limestone and potash were used with the two forms of phosphate, the yields on the superphosphate-treated plot (Plot 9) were appreciably larger than on the one treated with rock phosphate (Plot 10).

Comparing Plots 6 and 9, there is a difference in yields in favor of potash amounting in value to about the cost of the potash. When Plots 7 and 10 are compared, there is a slight margin in favor of Plot 7, which has no potash applied to it. This is probably due to soil variation. It is probable that on soils like these, which have not been drained, the use of potash in the fertilizer will prove profitable. However, the most important requirements for improving soils of this nature are the use of limestone, phosphate fertilizers, the growing of legumes, and the use of all the manure that can be produced.

Manure used without lime or fertilizer produced a large increase in corn and a fair increase in soybean hay. Unfortunately, the effect of manure used in addition to lime and fertilizers cannot be determined from these results. The difference in the yields of the first and second periods is probably due to the use of manure. Four of the eight corn crops of the first period and all the corn crops of the second period were manured.

Tests on wet land, not tile-drained, adjoining the experiment field have shown that, by the use of lime and phosphate fertilizers, good sweet clover, corn and soybeans can be grown.

For recommendations on soil management and fertilizer practices, see page 410.

THE FARISTON EXPERIMENT FIELD

N. M. Byble, Foreman

The Fariston Soil Experiment Field was established in 1916. It is located about five miles south of London, Laurel County,* on U. S. Highway No. 25. The soil is a yellow silt loam. It has a rather tight, yellow, silty clay subsoil of rather poor drainage. It is derived from shale and sandstone and is fairly typical of a considerable area of land at the base of the coal measures on the western border of the Eastern Coal Field. The soil is naturally rather unproductive and was very badly worn when work was begun. An analysis of a sample of surface soil from this field gave the following results, stated as pounds in 2,000,000 pounds of soil (the weight of an acre to the depth of about 7 inches):

* The land for this experiment field was provided by Laurel County, whose helpful cooperation is hereby acknowledged.

Total nitrogen	2,300 lbs. per acre
Total phosphorus	820 lbs. per acre
Total potassium	24,400 lbs. per acre

The soil is strongly acid (pH 4.5)

The rotation used on this field until 1922 was corn, soybeans, wheat and clover. After that date, rye was substituted for wheat and clipped and left on the ground unless the clippings were heavy enough to injure the young clover and grass. The soil was poorly adapted to wheat, both on account of its texture and its impoverished condition. The average yield on the best plot for 4 years was 12.1 bushels per acre, there being two failures in the six years. Wheat was restored to the rotation with the crop of 1929. A rye cover crop follows the corn. From 1916 to 1926, the clover sod was plowed immediately after clover harvest and seeded to soybeans or cowpeas, which were either plowed under or disked down (removed from Plot 2 from 1920 to 1926), followed by a rye cover crop plowed under before corn. From 1920 to 1924 the cornstalks were left on the ground, except on Plot 2. The plan was to use manure regularly after the first round of the rotation on all plots except No. 2, but it could not be obtained until 1925, when its use was begun on one half of each plot, as will be described later.

Superphosphate was used at the rate of 800 pounds per acre for the four-year rotation until 1928, when the amount was reduced one half. Bone meal was used to furnish the same amount of phosphorus as in the superphosphate. Rock phosphate was used at twice the rate of superphosphate. Muriate of potash, or its equivalent in other potash carriers, was used at the rate of 200 pounds per acre for the rotation, except that from 1922 to 1927 twice this amount was used.* Limestone was used in three applications of 2 tons each, between 1916 and 1923.**

One half of the fertilizers, except rock phosphate, was applied for the corn crop, and until 1925 the other half was applied for the third crop (wheat or rye). From 1925 to 1929 the second half was applied for the soybean crop. In the fall of

* The use of extra potash was due to a misunderstanding of plans which arose in the change of superintendents and in changing from a low-grade potash salt to a standard muriate.

** It was intended to use only two applications of limestone, of 2 tons each, but a misunderstanding of plans also arose in the change of superintendents. These errors were not detected until after the publication of Bulletin No. 272 in 1925.

Table 2. Crop Yields Per Acre, Fariston Soil Experiment Field.

Serial Plot No.	Treatment*	Corn, Bus., Ave. 14 Crops				Soybean Hay, Lbs., Ave. 15 Crops				Wheat, Bus., Ave. 6 Crops		Clover Hay, Lbs., Ave. 11 Crops			
		First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment	Yield	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment
1	O	11.7	6.7	9.2	.....	1179	1231	1207	.....	2.3	.....	155	287	227	.....
2	O	11.0	5.7	8.4	—0.8	1324	1238	1278	—35	2.2	—0.2	111	97	103	—153
3	L	17.3	17.4	17.4	8.0	1629	2201	1934	515	4.3	1.8	465	615	547	262
4	O	10.7	8.0	9.4	.....	1332	1694	1525	.....	2.6	.....	283	340	314	.....
5	RP	32.7	33.8	33.3	24.3	2427	3179	2828	1372	7.4	5.1	923	1292	1124	859
6	Bm	32.5	27.4	29.9	21.2	2330	3039	2708	1322	8.0	5.9	790	922	862	646
7	O	12.2	4.5	8.3	.....	1177	1446	1317	.....	1.8	.....	116	210	167	.....
8	P	30.0	22.6	26.3	18.6	1916	2308	2125	841	5.9	3.9	823	868	848	703
9	PK	31.2	28.3	29.7	22.5	2187	2636	2427	1175	7.9	5.8	917	1342	1149	1025
10	O	8.3	5.0	6.6	.....	1086	1336	1219	.....	2.3	.....	48	147	102	.....
11	LP	39.4	46.3	42.8	35.2	3367	4815	4139	2901	11.1	8.7	1565	2448	2047	1905
12	LPK	40.7	48.6	44.6	36.0	3411	5389	4466	3210	11.7	9.1	1951	2788	2408	2226
13	O	12.7	6.5	9.6	.....	1156	1379	1275	.....	2.7	.....	141	290	222	.....
14	LRP	26.6	32.3	29.5	20.0	2173	3615	2942	1682	6.4	3.8	828	2000	1467	1224
15	N-P-K	29.3	29.5	29.4	20.0	1721	2405	2026	842	7.6	5.2	664	923	865	542
16	O	8.4	10.3	9.3	.....	1037	1398	1229	.....	2.3	.....	106	432	284	.....

* O = no fertilizers or limestone (Cowpea catch crop removed from plot 2); L = limestone; RP = rock phosphate; Bm = steamed bone meal; P = superphosphate; K = potash; N-P-K = complete fertilizer (see explanation). None of the crops in this table were manured.

† Crop increases calculated by assuming uniform variation of soil between check plots (Nos. 1, 4, 7, etc.). See page 357.

1930 the second half of the application was changed to wheat, this crop having been restored to the rotation the preceding year. The entire application of rock phosphate was made on the corn ground, except for the first three years when it was applied at the same time as the other fertilizers. The fertilizers were applied on the broken ground and worked in, in the preparation of the land for planting (on soybean stubble for wheat and rye), except that some of the applications of rock phosphate were made before plowing. On Plot 15 a complete fertilizer was used, as indicated in the statement following the table of crop yields.

The crop yields for the various fertilizer treatments for the fifteen-year period are given in Table 2. Each crop, except wheat, is given in averages for two periods. The corn crop of 1930 is not included, because it was almost a failure on account of drouth.

There were four years in which no clover hay was produced A crop could not be had the first year, and the crops of 1917, 1924 and 1926 were failures. The failures are not included in the averages. Clover alone was sown until the crop of 1926, when timothy and common lespedeza were added. Sweet clover was included from 1927, and Korean lespedeza and redtop from 1928. In some of the later years unfavorable for clover, the hay contained a large proportion of grass.

On Plot 15 a 2-8-2 fertilizer was used from 1916 to 1922, inclusive, at the rate of 400 pounds per acre on corn and 400 pounds on the grain crop. Of the application on corn, one half was put in the hill and one half used as a side-dressing or broadcast. From 1923 to 1927, instead of the 2-8-2 fertilizer, superphosphate was used on this plot at the same rate as on the superphosphate plots. One hundred pounds of the superphosphate, 30 pounds of muriate of potash and 100 pounds of nitrate of soda per acre were mixed and used in the hill for corn. Beginning with 1928, one half of these amounts were used for corn. In 1923 and 1924 the same application was used on rye (in the fall) as on corn, and from 1925 to 1929 on soybeans, except that the nitrate of soda was left off from 1926 to 1929. Wheat having been restored to the rotation, the second half of the phosphate and potash application was changed to this crop

in 1930, with nitrate of soda used at the rate of 100 pounds per acre as a spring top-dressing.

The yield of corn for the complete fertilizer when 2-8-2 was used (1916-1922) was 29.3 bushels per acre, against 8.4 bushels on the nearest check plot (No. 16). The yield for superphosphate (Plot 8) was 30 bushels per acre, against 12.2 bushels on the nearest check (Plot 7). By this method of comparison there was a gain of 3.1 bushels per acre for the complete fertilizer plot over the superphosphate plot. If the increase is computed by assuming a uniform variation from one check plot to another, the increase for superphosphate was 19.1 bushels per acre, and for the complete fertilizer 19.5 bushels per acre. The yield for the limestone-superhosphate plot (No. 11) for this period was 39.4 bushels per acre against 8.3 bushels on the nearest check plot (No. 10), an increase of 31.1 bushels per acre. Using the two nearest check plots (Nos. 10 and 13) and assuming a uniform soil variation between them, the increase for lime and superphosphate was 29.6 bushels per acre. Taking the period 1923 to 1929, when the higher analysis mixtures were used, the increases are as follows:

	Super-phosphate	Complete Fertilizer	Limestone Super-phosphate
Compared with nearest check..	18.1	19.2	41.3
Using check plot variations.....	17.9	20.5	40.8

Beginning in 1925, all plots (except No. 2) in each series were divided into halves previous to planting corn, and on one half manure was used at the rate of 6 tons per acre for one round of the rotation. After this, manure was returned to these half plots, when planted to corn, at a rate equal to the weight of the crops removed from the corresponding plots the previous year. Thus 5 corn crops have been manured and 5 bean crops, 2 wheat crops and 3 clover crops have had the residual effect of these applications of manure. The yields of crops for these periods are given in Table 3.

DISCUSSION OF RESULTS

The crop yields on this field indicate that there is very little hope of bringing soils of this kind to a high state of pro-

ductiveness without a liberal use of phosphate fertilizers and limestone. Fortunately, there is an abundance of limestone close to most of this area which can be used at a reasonable cost on land within hauling distance of railroad stations.

Table 3. Crop Yields Per Acre in the Manure Test, Fariston Soil Experiment Field.

Plot No.	Treatment	Corn, Bus. Ave. 5 Crops		Soybean Hay, Lbs. Ave. 5 Crops		Wheat, Bus. Ave. 2 Crops		Clover Hay, Lbs. Ave. 3 Crops	
		Manure	No Manure	Manure	No Manure	Manure	No Manure	Manure	No Manure
1	O	18.3	7.0	2000	920	0.4	0.1	453	307
2	None*	4.6	5.4	1372	1028	0.0	0.0	153	127
3	L	32.5	16.4	3480	1636	2.1	1.6	993	760
4	O	20.9	7.9	2544	1426	1.0	0.7	860	547
5	RP	40.5	30.9	3792	2772	7.1	6.2	1860	1473
6	Bm	31.0	25.3	3752	2700	3.9	3.7	1240	893
7	O	14.1	4.4	1756	1228	0.6	0.3	433	320
8	P	25.1	26.2	2660	1964	3.7	3.1	920	687
9	PK	29.8	31.6	3584	2736	5.6	4.8	1807	1307
10	O	13.3	5.5	1612	1364	0.7	0.6	427	193
11	LP	53.1	48.4	5916	4932	12.2	9.1	3027	2647
12	LPK	49.7	50.5	6008	5552	14.0	12.0	3073	2693
13	O	13.1	7.0	1412	1206	1.6	1.2	540	413
14	LRP	42.8	33.0	4448	3644	7.9	6.6	2393	2140
15	N-P-K	35.4	31.2	2720	2152	6.9	8.0	1307	707
16	O	17.2	9.5	1916	1452	1.1	0.9	647	480

* No manure on either half of Plot 2.

The effect of potash, tho used in liberal quantities, has not been very great when the whole period is considered. It has been more effective in the second period than in the first, as would be expected where there has been no return of manure. Unless manure or crop residues are returned to the soil, a deficiency of available potash may be expected sooner or later.

On land that had not been limed, both bone meal and rock phosphate were decidedly more effective than superphosphate at the rates used. The results in Table 2 indicate that the effectiveness of rock phosphate is depressed by limestone on soil of this character. Some of the later results indicate that some time after liming, rock phosphate may be used without this depressing effect from lime.

It is interesting to note the effect of superphosphate and complete fertilizer on corn with and without manure (see Table 3).

	Yield		Increase	
	Without Manure	With Manure	Without Manure	With Manure
Superphosphate (Plot 8)	26.2 bus.	25.1	21.4	11.3
Complete fertilizer (Plot 15)..	31.2	35.4	22.5	19.6

This is in keeping with the results of some unpublished experiments on hill fertilization of corn, from which there seems to be a medium state of fertility in which complete fertilizers are relatively more effective than on either richer or poorer soil. Hill fertilization with complete fertilizers gives the corn a more vigorous start on thin to medium land, but the thin soil does not furnish enough plant food to continue this early advantage in growth, whereas the medium land does. The more highly fertile land supplies the necessary plant food for the early growth.

Demonstrations on land on this field unsuited to plot work have shown that by the use of lime and superphosphate excellent sweet clover and orchard grass can be grown on this soil; also, by treatment with superphosphate alone good orchard grass, redtop and lespedeza mixtures can be grown. Much of the abandoned or unproductive land in this region could be converted into productive pastures by treating it according to these suggestions. For recommendations on soil management and fertilizer practices, see page 410.

THE CAMPBELLSVILLE SOIL EXPERIMENT FIELD

N. A. McKinley, Foreman

The Campbellsville Soil Experiment Field* was established in 1919. It is located about one mile northwest of Campbellsville in Taylor County. The soil is derived from the Waverly formation, which is made up of limestone and shale. The major or a large portion of the following counties is covered by this formation: Allen, Adair, Barren, Bullitt, Casey, Green, Lewis, Monroe, Rowan, and Taylor. The formation is found in smaller areas in Boyle, Clinton, Cumberland, Estill, Garrard, Jefferson, Larue, Lincoln, Madison, Marion, Menifee, Montgomery, Nelson,

* The land for this field was provided by Taylor County, whose helpful cooperation is hereby acknowledged.

Powell, Pulaski, Rockcastle, Wayne, and possibly some other counties.

The soil of this field was in a very unproductive condition when work was begun. The average of the analyses of a number of samples from the field shows the soil to contain approximately the following amounts of nitrogen, phosphorus and potassium in 2,000,000 pounds of soil (the weight of an acre to the depth of about 7 inches):

Total nitrogen	2,375 lbs.
Total phosphorus	1,100 lbs.
Total potassium	13,000 lbs.

The soil is moderately acid (pH 5.5).

In this area are found numerous marl deposits that are weathering and supplying lime to soils on the slopes below them. No doubt old beds have weathered out and affected the reaction of the soil in many places where deposits do not now appear. The weathering of these marls doubtless explains the successful growing of red clover, sweet clover and alfalfa without liming often reported from this area.

On the Campbellsville field three series of nineteen plots each were devoted to a general fertilizer test in a rotation of corn, wheat and clover. Three series of sixteen plots each were used for a test of rates of application of superphosphate and rock phosphate in a rotation of corn, wheat and clover. Three series of thirteen plots each were used for fertilizer tests on tobacco. Until 1929 a rotation of tobacco, wheat and clover was used in the tobacco tests. In 1929 a transition was begun to a six-year rotation of tobacco two years, wheat, clover and grass for three years. This change will be fully established in 1933, when tobacco will follow a four-year old grass sod for the first time.

In all three tests a mixture of red and alsike clover was used for the third-year crop thru 1924. Timothy was introduced in 1925 (year of harvest), common lespdeza in 1926, alfalfa in 1927, and Korean lespedeza in 1928. Each of these was continued in the mixture from the time it was introduced. (This statement is true for the tobacco rotation thru 1928, after which the rotation was changed.)

The cropping for 1919 was preliminary, and no yields are included for that year.

THE GENERAL FERTILIZER TESTS

Fertilizers and limestone were used as follows:

Limestone at the rate of 2 tons per acre twice between 1919 and 1924.

Superphosphate at the rate of 600 pounds per acre for the rotation.

Basic slag in amounts to furnish approximately the same amount of phosphorus as the superphosphate.

Muriate of potash, or its potash equivalent, at the rate of 150 pounds per acre for the rotation.

Nitrate of soda at the rate of 100 pounds per acre for corn and 100 pounds per acre for wheat.

All materials except the nitrate of soda were applied broadcast after breaking the ground and disked in, except that for a brief period following the war, when potash was scarce, the application was divided between corn and wheat. The nitrate of soda was applied around the corn hills, between planting time and when corn was a few inches high. The application to wheat was made in the spring when growth began.

It was planned to begin the return of manure in 1923 with the second round of the rotation, but manure could not be obtained at that time. Its use was begun in 1926, when it was applied on all plots except No. 2, at the rate of 5 tons per acre, on the corn ground. It was used in the same manner at 6 tons per acre in 1927, and 5 tons per acre in 1928. Beginning with 1929, manure was applied to all plots, except No. 2, at the rate of 1 ton for each ton of produce removed from the corresponding plots the preceding year, wheat grain excepted (see page 359). Three wheat crops and three clover crops have had the residual effect of the manure applied to the corn ground.

In 1919, cowpeas and soybeans were grown and turned under on the series that grew corn in 1920. A light growth of crimson clover was turned under for the corn crop of 1921. In 1923 and 1924 the clover crops were almost failures and were left on the ground, followed by cowpeas which were plowed under for the benefit of the corn crops of 1924 and 1925. After

clover harvest in 1925, the ground was seeded to soybeans, which were turned under.

The crop yields in this test are given in Table 4.

Corn for 1930 was almost a failure, due to drouth, and is not included (see page 361). Wheat was a failure in 1920, 1924 and 1928, due partly to unfavorable winters. The earlier failures no doubt were due in part to the impoverished condition of the soil. The first clover crop attempted (1920 crop) was a failure. Also, as already stated, the clover crops of 1923 and 1924 were failures. The clover and grass crop for 1926 failed, but lespedeza in the mixture reseeded itself in 1925 and made a good growth. It was harvested and the yields are included in the averages as a regular hay crop (see also Table 7). It is probable that these clover failures were due to the use of an unadapted strain. A Kentucky-grown adapted strain has been sown beginning with the crop of 1929. Crop failures are not included in the averages.

In 1929 the fertilized plots in the general fertilizer test were divided. On one half of the plot all the phosphate and potash was applied broadcast and the nitrate of soda was applied around the hill before the corn came up. On the other half, 95 pounds per acre of the phosphate and 15 pounds of the potash were applied in the hill at planting time, and the nitrate of soda was used as on the first half. Where both phosphate and potash were used, the application was the equivalent of 150 pounds per acre of 0-10-5 fertilizer in the hill. An average of ten plots used in each method showed practically no difference in yields, nor was there any advantage of hill application as an average of four tests in which complete fertilizers were used. The trial will be continued with 50 pounds of nitrate of soda per acre. For the complete fertilizer treatment, the hill application will amount to 165 pounds per acre of a 5-10-5 analysis (approximate). The object of the test is to determine whether hill fertilization has any advantage under the system of management used on this field. No conclusions should be drawn from one year's results. (See discussion of hill fertilization under Fariston field; also under "Recommendations.")

Table 4. Crop Yields, Per Acre, General Fertilizer Test. Campbellsville Experiment Field.

Plot No.	Treatment*	Corn, Bus. Ave. 10 Crops				Wheat, Bus. Ave. 8 Crops				Clover Hay, Lbs. Ave. 8 Crops			
		First Period	Second Period	Both Periods	Increase Due to Treatment†	First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment
1	M	18.8	28.1	23.5		4.4	3.4	3.9		833	915	874	
2	None	18.4	10.9	14.7	—8.4	3.6	1.4	2.5	—0.9	643	515	579	—248
3	ML	24.1	35.5	29.8	7.0	5.0	4.6	4.8	1.9	1083	1328	1205	425
4	M	19.9	24.9	22.4		2.7	2.1	2.4		648	818	733	
5	MP	39.6	53.3	46.4	20.4	7.6	8.4	8.0	4.9	1650	2728	2189	1290
6	MPK	42.3	53.8	48.1	18.5	8.8	9.8	9.3	5.4	2010	2973	2491	1427
7	M	30.5	35.8	33.2		5.6	3.6	4.6		973	1488	1230	
8	MPN	46.4	58.2	52.3	20.7	11.5	12.2	11.9	7.7	1863	2928	2395	1120
9	MPKN	45.5	58.8	52.2	22.3	12.7	13.4	13.0	9.1	2073	3208	2640	1319
10	M	25.2	31.4	28.3		4.0	3.1	3.5		1115	1618	1366	
11	MBsKN	43.2	57.7	50.5	23.0	11.1	14.4	12.7	9.2	1968	3298	2633	1372
12	MLP	45.7	61.0	53.4	26.7	8.2	11.9	10.1	6.7	2360	3440	2900	1744
13	M	21.8	30.0	25.9		3.9	3.0	3.4		950	1153	1051	
14	MLPK	48.0	61.4	54.7	27.7	10.4	12.9	11.6	7.9	2333	3685	3009	1966
15	MLPN	46.1	62.8	54.5	26.4	13.4	15.5	14.4	10.5	2180	3568	2874	1838
16	M	25.1	33.3	29.2		4.5	4.0	4.2		820	1235	1028	
17	MLPKN	46.8	62.5	54.7	26.8	14.3	16.1	15.2	11.0	2443	3718	3080	2100
18	MLBsKN	44.9	59.9	52.4	25.7	13.6	16.9	15.3	11.0	2063	3603	2833	1900
19	M	21.0	29.7	25.4		4.3	4.3	4.3		700	1070	885	

* M = manure on corn since 1926; L = limestone; P = superphosphate; K = potash; Bs = basic slag phosphate; N = nitrate of soda.

† Increases are the yields above those of the manured check plots (1, 4, 7, etc.). Increases were calculated by assuming a uniform variation of soil between check plots (see page 357).

THE PHOSPHATE TESTS

Limestone, fertilizers and manure were used in the same way as in the general fertilizer test (see page 374) except for the amounts of phosphate applied, which are indicated in the table of yields (Table 5). The rock phosphate was applied on the unbroken corn ground and plowed under, thru 1925; after that, on the broken ground. Cowpea or soybean catch crops were used in this rotation as in the general fertilizer test. The crop failures occurred at the same time in this test as in the general fertilizer test, except that a light clover crop was harvested in these tests in 1923 when the crop was a failure in the general fertilizer tests. In 1924 fire caught in the dead grass and weeds on part of a number of plots and so injured the clover that it was plowed up and the plots seeded to cowpeas which were turned under. Lespedeza was harvested in 1926 and the yields are included in the hay average, as in the general fertilizer tests.

The crop yields for the phosphate tests are given in Table 5.

In the phosphate tests, when four rounds of the rotation will have been completed, applications will be discontinued on those plots receiving 900 pounds of superphosphate and 1,800 pounds of rock phosphate per acre. The 600-pound application of superphosphate in the general fertilizer test will be reduced to 300 pounds, and the 1,200-pound rate of rock phosphate with which it has been compared will be reduced to 600 pounds. The 300-pound application of superphosphate and the 600-pound application of rock phosphate will be continued. This will give opportunity to study the effect of the reserves of phosphorus built up by the heavier applications. The four applications of 1,800 pounds per acre of rock phosphate have added approximately 1,000 pounds of phosphorus per acre, which is nearly as much as the surface 7 inches of soil originally contained.

THE FERTILIZER TESTS ON TOBACCO

As already stated, the rotation used in this test was tobacco, wheat and clover thru 1928, when a change was begun to a six-year rotation of tobacco, tobacco, wheat, legume and grass mixture three years. The mixture used is bluegrass, redtop, red and alsike clover, common and Korean lespedeza.

Table 5. Crop Yields Per Acre, Phosphate Tests. Campbellsville Experiment Field.

Plot No.	Treatment*	Corn, Bus. Ave. 10 Crops				Wheat, Bus. Ave. 8 Crops				Clover Hay, Lbs. Ave. 9 Crops			
		First Period	Second Period	Both Periods	Increase Due to Treatment†	First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment
1	M	19.1	23.6	21.3	.....	4.9	3.9	4.4	.....	696	1277	1019	.....
2	M (P 300 lbs.)	34.0	40.6	37.3	13.2	6.7	8.1	7.4	2.6	1140	2254	1759	591
3	M (RP 600 lbs.)	36.1	47.5	41.8	15.0	8.9	10.5	9.7	4.4	1737	2983	2429	1113
4	M	27.0	32.1	29.6	.....	6.1	5.3	5.7	.....	945	1882	1465	.....
5	M (P 900 lbs.)	44.5	51.2	47.8	18.1	10.6	12.4	11.5	6.0	2466	3502	3041	1636
6	M (RP 1800 lbs.)	45.0	54.4	49.7	19.8	10.8	13.0	11.9	6.5	3150	4186	3725	2380
7	M	27.0	32.9	30.0	.....	5.3	5.0	5.2	.....	804	1670	1285	.....
8	ML (P 300 lbs.)	40.2	48.4	44.3	14.4	8.5	11.6	10.0	4.7	1518	2503	2065	802
9	ML (RP 600 lbs.)	33.4	41.9	37.6	7.8	7.4	8.5	7.9	2.5	1409	2340	1926	684
10	M	24.1	35.4	29.7	.....	5.1	5.9	5.5	.....	912	1466	1220	.....
11	ML (P 900 lbs.)	48.9	59.4	54.2	24.8	12.8	16.2	14.5	8.8	3258	4195	3779	2504
12	ML (RP 1800 lbs.)	41.1	46.9	44.0	15.0	9.0	10.5	9.7	3.9	1932	3324	2705	1375
13	M	24.3	33.1	28.7	.....	5.2	6.8	6.0	.....	927	1752	1385	.....
14	M (RP 1200 lbs.)‡	39.1	53.1	46.1	17.6	8.5	12.7	10.6	4.2	2517	4241	3475	2109
15	ML (RP 1200 lbs.)‡	36.1	44.7	40.4	12.2	8.0	9.6	8.8	2.1	1542	2777	2228	882
16	M	23.9	32.2	28.0	.....	6.6	7.5	7.1	.....	927	1646	1327	.....

* Figures in this column are rates of phosphate per acre per rotation. RP = rock phosphate. See Table 4 for other symbols.

‡ Comparison with superphosphate, 600 pounds per acre, can be made by using yields from Plots 5 and 12 of the general fertilizer tests, Table 4.

† Increases computed as in Table 4.

Limestone was used at the rate of 2 tons per acre twice between 1919 and 1924.

Manure was used at a uniform rate of 5 and 6 tons per acre on all tobacco plots from 1926 to 1930.

Until 1925, superphosphate was used at the rate of 600 pounds per acre for the rotation, and applied broadcast on the tobacco ground after breaking.

Sulfate of potash, or its potash equivalent, was used at the rate of 150 pounds per acre for the rotation, for the same time and in the same way.

Nitrate of soda was used at the rate of 100 pounds per acre on the first tobacco crop (1922), and applied along the row after the tobacco was set. In 1923, 1924 and 1925, 200 pounds per acre were used for tobacco, applied broadcast together with the phosphate and potash.

From 1926 to 1928 the fertilizers were used part on tobacco and part on wheat. The following amounts were used on tobacco, applied broadcast:

Superphosphate	350 lbs. per acre
Sulfate of potash	50 lbs. per acre
Nitrate of soda	200 lbs. per acre

For the wheat following tobacco, 250 pounds of superphosphate and 100 pounds of muriate of potash were applied.

When the rotation was changed, as indicated above, the fertilizer applications were made for each of the tobacco crops and no more was added for the other crops of the rotation except nitrate of soda for wheat. The application was 300 pounds of superphosphate, 100 pounds of sulfate of potash, and 200 pounds of nitrate of soda. Part was used in the row and part broadcast.

Thruout the entire period, nitrate of soda was applied as a top-dressing for wheat, at the rate of 100 pounds per acre, when spring growth began. The total applications of the various fertilizing materials are equivalent to annual applications of approximately the following amounts:

Superphosphate	200 lbs.
Sulfate of potash	45 lbs.
Nitrate of soda on tobacco	185 lbs.

Catch crops of legumes have been used in this test as in the general fertilizer test.

Table 6. Crop Yields Per Acre in Fertilizer Tests on Tobacco. Campbellsville Experiment Field.

Plot No.	Treatment	Tobacco, Lbs. Ave. 8 Crops*				Wheat, Bus. Ave. 7 Crops				Clover Hay, Lbs. Ave. 9 Crops			
		First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment
1	M	402	593	497		8.2	12.1	10.4		897	1298	1120	
2	MP	861	929	895	390	15.9	18.9	17.6	7.6	2013	2382	2218	1080
3	MPK	855	961	908	394	14.9	21.6	18.8	9.1	1782	2470	2164	1009
4	M	483	562	522		7.7	10.5	9.3		1010	1303	1173	
5	MPN	908	1050	979	447	17.1	24.1	21.1	11.7	1941	2734	2382	1135
6	MPKN	1059	1087	1073	530	16.2	26.0	21.8	12.4	2514	2889	2722	1400
7	M	449	658	553		8.4	10.3	9.5		1047	1676	1396	
8	MLP	802	886	844	316	16.7	24.4	21.1	12.1	2796	3023	2922	1676
9	MLPK	879	827	853	349	16.5	23.9	20.7	12.3	2785	2924	2862	1765
10	M	420	537	479		7.4	8.3	7.9		820	1049	947	
11	MLPN	785	846	815	304	17.3	25.3	21.9	13.8	2223	3476	2919	1839
12	MLPKN	995	1196	1095	552	18.1	24.1	21.6	13.3	2733	3835	3345	2133
13	M	473	678	575		7.8	9.0	8.5		852	1740	1345	

* See Table 4 for symbols and method of computing increase.

The crop yields in this test are given in Table 6.

Tobacco was a failure in 1920. It was not set in 1921, because of lack of moisture. It was practically a failure in 1930 on account of drouth, and yields are not used. The one-sucker type of dark tobacco was grown from 1922 to 1926; White Burley since.

Wheat was a failure in 1920, 1924 and 1928.

Clover failures occurred at the same time in this rotation as in the phosphate test.

Lespedeza hay was harvested in 1926 as in the other tests, and the yields are included in the averages.

Mention was made in the introductory statement of the use of different plants in the mixture for hay in the different tests. The seeding mixture of 1925 contained red clover, alsike, timothy, and common lespedeza (5 pounds per acre). The clovers and timothy were practically a failure, but the lespedeza reseeded itself in 1925 and gave a good stand in 1926 which made growth sufficient for a hay crop. The weights are given in Table 7.

Table 7. Lespedeza Hay Yields Per Acre. Campbellsville Experiment Field, 1926.

Corn-Wheat-Clover Rotation			Tobacco-Wheat-Clover Rotation			Phosphate Tests Corn-Wheat-Clover Rotation		
Plot No.	Treatment	Yield Per Acre, Lbs.	Plot No.	Treatment	Yield Per Acre, Lbs.	Plot No.	Treatment*	Yield Per Acre, Lbs.
1	O	1460	1	O	708	1	O	1692
2	O	810	2	P	1332	2	P 300	2184
3	L	1560	3	PK	1908	3	RP 600	2196
4	O	630	4	O	1116	4	O	2088
5	P	2160	5	PN	1512	5	P 900	2424
6	PK	2200	6	PKN	1560	6	RP 1800	4452
7	O	1230	7	O	1740	7	O	2364
8	PN	1870	8	LP	1536	8	LP 300	2868
9	PKN	2690	9	LPK	1020	9	LRP 600	2592
10	O	2060	10	O	264	10	O	1164
11	BsKN	2460	11	LPN	2040	11	LP 900	4332
12	LP	2530	12	LPKN	2976	12	LRP 1800	3504
13	O	1220	13	O	1620	13	O	1824
14	LPK	2880				14	RP 1200	4524
15	LPN	2140				15	LRP 1200	3252
16	O	1070				16	O	1488
17	LPKN	2050						
18	LBsKN	2070						
19	O	710						

* Figures are rates of phosphate per acre per rotation.

The differences in yield are not very consistent with the differences in treatment. It is a common observation on the experiment fields that the stand of lespedeza the second year is greatly influenced by the growth of the various forage plants. The heavier the growth of other plants, the thinner the stand of lespedeza. Some of these plots had considerable growth of weeds and wild grass on them, both in 1925 and 1926. However, in the main the growth was lespedeza.

For the 1929 hay crop and the seeding of 1929 the grass and legume mixture seeded in the corn rotations consisted of red clover, alsike clover, common and Korean lespedeza, alfalfa and timothy. A second crop was harvested following the regular crop on the fertilized plots. There was a good stand of lespedeza on the other plots but it did not make sufficient growth to mow, because of the late summer drouth. A crop was harvested from the spring seeding also. This crop had some wheat stubble in it that exaggerates the yields to some extent.

In the tobacco rotation the mixture was red clover, alsike, common and Korean lespedeza, orchard grass and bluegrass for the crop for harvest in 1929, and for the spring seeding of 1929 it was the same except that redtop was substituted for orchard grass, the grasses being seeded the preceding fall. The same cuttings were made in this rotation as in the corn rotation.

The second crop consisted almost entirely of clover on unlimed plots and of clover and alfalfa on limed plots. In the tobacco rotation it was almost wholly clover. The cutting from the 1929 seeding was chiefly clover.

Yields for all cuttings in 1929 are given in Table 8. The extra cuttings are not included in the hay averages in Tables 4, 5 and 6.

DISCUSSION OF RESULTS

In all tests in which phosphate fertilizers have been used, they have been highly effective. No test in which phosphate has been omitted has produced satisfactory yields. Available phosphorus is so deficient in this soil that it is not possible greatly to increase yields by the use of any amount of manure that can be produced from the yields of crops grown without phosphate fertilization.

Table 8. Hay Yields, Lbs. Per Acre, 1929. Campbellsville Soil Experiment Field.

GENERAL FERTILIZER TEST

Plot No.	Treatment*	1928 Seeding			1929 Seeding	Total All Cuttings
		1st Cut	2nd Cut	Total		
1	O	1130	———	1130	1750	2880
2	O	710	———	710	410	1120
3	L	1780	———	1780	500	2280
4	O	1170	———	1170	820	1990
5	P	4420	2630	7050	1620	8670
6	PK	4960	2400	7360	2300	9660
7	O	2360	———	2360	1900	4260
8	PN	4130	2530	6660	2470	9130
9	PKN	4550	2720	7270	2940	10210
10	O	2160	———	2160	2360	4520
11	BsKN	4620	2770	7390	2940	10330
12	LP	5070	2440	7510	3080	10590
13	O	1860	———	1860	1920	3780
14	LPK	5240	2720	7960	3450	11410
15	LPN	5100	2590	7690	3380	11070
16	O	1730	———	1730	2070	3800
17	LPKN	4760	3210	7970	3530	11500
18	LBsKN	4730	2690	7420	3740	11160
19	O	1420	———	1420	1660	3080

PHOSPHATE TESTS

1	O	1656	———	1656	1512	3168
2	P 300**	3168	1188	4356	1764	6120
3	RP 600	3792	1704	5496	2040	7536
4	O	2376	———	2376	1572	3948
5	P 900	4872	2328	7200	2532	9732
6	RP 1800	5484	2136	7620	2400	10020
7	O	1956	———	1956	1524	3480
8	LP 300	3120	1380	4500	2592	7092
9	LRP 600	3732	1656	5388	2280	7668
10	O	2016	———	2016	1380	3396
11	LP 900	5520	2280	7800	3660	11460
12	LRP 1800	5064	2112	7176	2856	10032
13	O	2244	———	2244	1848	4092
14	RP 1200	5508	2208	7716	3024	10740
15	LRP 1200	4068	1956	6024	2760	8784
16	O	2076	———	2076	1380	3456

TOBACCO ROTATION

1	O	900	880	1780	1260	3040
2	P	2320	1480	3800	2260	6060
3	PK	1880	1400	3280	2280	5560
4	O	920	860	1780	680	2460
5	PN	2960	2280	5240	2060	7300
6	PKN	3260	2220	5480	2960	8440
7	O	1220	1160	2380	1520	3900
8	LP	3780	2400	6180	4320	10500
9	LPK	3900	2380	6280	3520	9800
10	O	1140	920	2060	1340	3400
11	LPN	4060	2720	6780	5220	12000
12	LPKN	5220	3520	8740	4540	13280
13	O	2020	1780	3800	2380	6180

* All plots except No. 2 in the general fertilizer test were manured for the preceding corn or tobacco crop.

** Figures are rates of phosphate per acre per rotation.

Limestone used alone (Plot 3, Table 4) was not very effective. Limestone used with superphosphate, or mixtures containing superphosphate, has been profitable except for tobacco, tho not so profitable as on some of the other experiment fields. A comparison of all plots that were limed and fertilized with superphosphate, or mixtures containing superphosphate, with plots unlimed but similarly fertilized shows the following average annual increases per acre for limestone:

Corn	5.6	bus.
Wheat	2.4	bus.
Clover	636	lbs.
Tobacco, loss of	60	lbs.

With corn and wheat at 75 cents per bushel and hay at $15.00 per ton, the four tons of limestone were worth about $33.00.* These applications will be sufficient, in all probability, for several years more. There are soils in the area represented by this field that will grow good clover without liming if they are liberally fertilized with a phosphate fertilizer and if adapted seed is used.

On soils like those of this field, lime should be used very lightly where tobacco is to be grown, and it should not be applied immediately before tobacco. Too much limestone was used in the tobacco fertilizer tests. Tobacco is not directly benefited by lime unless the soil is much more strongly acid than is usually the case in this region. A light application of 1,000 to 2,000 pounds preceding the clover crop and applied as far ahead of the tobacco as possible usually benefits tobacco thru the clover. Frenching was observed a number of times on limed plots, but was never observed on the unlimed plots. The effect of the lime in depressing yields is most noticeable on plots without complete fertilizer (Plots 8, 9 and 11 as compared with Plots 2, 3 and 5). Where too heavy applications of lime are used, heavy fertilization with a high-grade complete fertilizer may largely counteract the effects of the lime (see Plot 12).

Price ratings were obtained for the 1927 and 1929 tobacco crops. The average price for the tobacco on Plots 2, 3 and 5

* This calculation is based on the actual number of crops harvested. In farm practice other crops would be substituted when failures occur, thus increasing the value for the use of lime.

(without lime) was $17.18 per hundredweight, while for Plots 8, 9 and 11 (with lime) it was $12.54. The price for Plot 6 (complete fertilizer without lime) was $22.91, whereas for Plot 12 (complete fertilizer with lime) it was $27.29. It should be noted that Plot 12 (limed) produced more clover than Plot 6 (not limed); the average for Plot 12 for the two years preceding these two tobacco crops was 3,658 pounds and for Plot 6, 1,930 pounds. (See recommendations, page 412, for use of lime on tobacco land.)

Basic slag produced practically the same results as superphosphate, both on limed and unlimed soil. The differences were within the limit of error due to soil variation.

The results from rock phosphate clearly indicate that it should not be used with lime on soils similar to this field. When all plots treated with rock phosphate only are compared with plots treated with the same amount of rock phosphate with lime, the following average increases per acre are found: (See Table 5.)

	Corn	Wheat	Clover
Rock phosphate without lime	17.5 bus.	5.0 bus.	1867 lbs.
Rock phosphate with lime	11.7 bus.	2.8 bus.	980 lbs.
Difference	5.8 bus.	2.2 bus.	887 lbs.

A comparison of all rock phosphate plots without lime with all superphosphate plots both without lime and with lime gives the following average increases: (Rock phosphate used at double the rates of superphosphate.)

	Corn	Wheat	Clover
Superphosphate without lime	17.2 bus.	4.5 bus.	1172 lbs.
Superphosphate with lime	22.0 bus.	6.7 bus.	1683 lbs.
Rock phosphate without lime	17.5 bus.	5.0 bus.	1867 lbs.

The effectiveness of potash on tobacco is shown by a comparison of Plot 5 with Plot 6 and Plot 11 with Plot 12, the average increase for this element in the fertilizer being 165

pounds per acre. When all treatments containing potash are compared with treatments similar except for potash the following increases for other crops are found:

	Corn	Wheat	Clover
Fertilizers with potash	23.8 bus.	10.1 bus.	1640 lbs.
Fertilizers without potash	23.5 bus.	9.4 bus.	1465 lbs.

The effectiveness of nitrogen for tobacco is shown by comparing Plot 3 with Plot 6 and Plot 9 with Plot 12, the average increase for this element in the fertilizer being 170 pounds per acre. Comparing all treatments containing nitrogen with treatments similar except for nitrogen, it is found that corn is increased 0.8 bushels per acre; wheat, 3.1 bushels; and hay, 115 pounds.

For recommendations on soil management and fertilizer practices, see page 410.

THE GREENVILLE SOIL EXPERIMENT FIELD

C. R. Lovell, Foreman

The Greenville Soil Experiment Field* was established in 1913. It lies about two miles west of Greenville, in Muhlenberg County. The soil is classed as Tilsit silt loam, and fairly represents the uplands of the Western Coal Field and the sandstone area on its borders. It is derived from interbedded shale and sandstone. An analysis of a sample of surface soil of this field gave the following results, stated as pounds in 2,000,000 pounds of soil (the weight of an acre to the depth of about 7 inches):

Total nitrogen	1,780 lbs.
Total phosphorus	660 lbs.
Total potassium	24,600 lbs.

The soil is moderately acid (pH 5.5)

THE FOUR-YEAR ROTATION

The land occupied by this rotation had very poor natural drainage. A tile drainage system was put in in the spring of

* The land for this experiment field was provided by Muhlenberg County, whose helpful cooperation is hereby acknowledged.

1916 on the part of the field occupied by the four-year rotation. The lines of tile are in the roadways, 120 feet apart, and are fairly effective.

Two rotations are used on this field. One is a four-year rotation of corn (rye cover crop), soybeans, wheat and clover.

Limestone was used at the rate of 2 tons per acre per rotation twice between 1913 and 1920, except that on one series it was used at the rate of 4 tons per acre for one application. The limestone was applied on the series for corn, except that fractional applications were used on the other series the first year as at Berea. These applications made an average of 5.25 tons per acre in 18 years. The limestone was screening of ¼ inch and finer.

Superphosphate was used at the rate of 800 pounds per acre for the four-year rotation period for two rounds of the rotation, after which the rate was reduced to 400 pounds per acre. Rock phosphate was used at double the rate of superphosphate.

Muriate of potash, or its potash equivalent, was used at the rate of 400 pounds per acre for the first three years and 200 pounds per acre since. An exception to this is Plot 6, which was amended in 1916 by the addition of muriate of potash beginning with the 200-pound rate.

The fertilizers were applied on the corn ground in the full amount for the rotation until 1924-26, when the applications were changed to the wheat ground. Fractional applications were used the first year as in the case of limestone. An exception was Plot 6, on which one third of the application of phosphate was applied on each of the first three crops from 1913 to 1916, when the treatment was amended as indicated above. Fertilizers and limestone were applied on the broken ground and disked in until the change was made to wheat, except that the rock phosphate usually was applied before breaking.

Total applications of limestone and the various fertilizing materials are equivalent to annual applications of approximately the following amounts:

Limestone	585 lbs.
Superphosphate	160 lbs.
Rock phosphate	320 lbs.
Muriate of potash or its equivalent (except Plot 6, 50 lbs.)	65 lbs.

A cowpea crop was grown on Series 200 in 1913 in lieu of clover and was plowed under for the corn crop of 1914. Manure was used at the rate of 6 tons per acre on the corn land, on all plots except No. 1, from 1916 to 1919, inclusive. From 1920 to 1924 the cornstalks were left on the ground and the wheat straw was returned to the corn ground of the next year (except Plot No. 1). From 1925 to 1930 manure was used on all corn plots, except No. 1, at a rate equal to the weight of crops removed from the corresponding plots the preceding year (wheat grain excepted), except in 1927 and 1928, when it was used at a uniform rate based on the weight of the crops removed from the check plots the preceding year. It was planned to use manure regularly from 1916 on, but it could not always be obtained. In 1923 and 1924, after harvesting the clover crops, which were poor, the ground was planted to cowpeas which were disked in and followed by rye.

Corn was so nearly a failure in 1913 that it was not husked; the 1930 crop practically failed, due to drouth, and is not included in the averages (see page 361). Soybeans were harvested for seed in 1915 instead of for hay. Wheat was not sown for the 1920 and 1926 crops on account of wet weather the previous fall. The first clover crop was harvested in 1915. The crop of 1925 was a failure, due to winterkilling. Soybeans were substituted, and harvested for hay. In 1928 clover was a failure on all except Plots 11 and 13, which made 500 and 770 pounds per acre, respectively. However, lespedeza was used in the mixture and made a fairly good crop of hay, making 2,490 pounds per acre on the best plot (No. 6). This crop is included in the average yields of clover hay.

Other plants have been included with clover as follows (year of harvest given) for the purpose of observation (see page 360):

1916	Orchard grass and tall meadow oat grass
1917	Sweet clover and timothy
1918–19	Sweet clover
1921	Timothy
1926	Common lespedeza and timothy
1927	Common lespedeza, timothy and alfalfa
1928	Common and Korean lespedeza, alfalfa, timothy

All additions since 1926, inclusive, have been continued to the present.

The crop yields for the various fertilizer treatments in this rotation are given in Table 9. Yields are not given for Plots 6, 9 and 11 for the first period for the reason that the treatments were changed in 1916. Potash was added to Plot 6, formerly receiving superphosphate only. Superphosphate was added to Plot 9, formerly receiving potash only, and to Plot 11, formerly receiving limestone and potash. (See Bulletins 228 and 272 for yields on these plots up to 1925).

Five series of plots were used for this rotation a large part of the time, Series 100 and 500 being used as duplicates for the same crop. It was originally intended to have grass as an addition to the rotation, but the plan was changed beginning with 1917.

Below are the increases per acre for the second period of the plots where the treatments were changed in 1916 and of those with which they should be compared:

Plot	Treatment	Corn Bus.	Soybean Hay Pounds	Wheat Bus.	Clover Pounds
4	MP	11.1	1032	7.3	1769
6	MPK	12.3	909	9.4	1972
9	MPK	13.4	743	9.1	1430
7	MLP	20.6	1570	14.6	2467
11	MLPK	23.9	1750	14.2	2718

DISCUSSION OF RESULTS IN THE FOUR-YEAR ROTATION

Because of the variation in soil productivity so evident on this field, the small number of check plots used is inadequate to measure the effects of various treatments accurately enough, especially where the increases are small. However, an examination of the results warrants the following conclusions:

1. No great improvement can be made in the productiveness of this soil without the use of phosphate fertilizers.

2. Liming in connection with the use of superphosphate has produced sufficient crop increases to make it profitable. In connection with rock phosphate, however, the profitableness of limestone is questionable, at least when used in as large amounts as on this field. A lighter application might have been profitable, for it is well known that, on certain types of soil, lime has a

Table 9. Average Crop Yields, Four-Year Rotation. Greenville Soil Experiment Field.

Plot No.	Treatment*	Corn, Bus. Ave 16 Crops				Soybean Hay, Lbs. Ave. 17 Crops				Wheat, Bus. Ave. 15 Crops				Clover Hay, Ave. 15 Crops			
		First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment
1	O	19.5	13.8	16.6	—10.6	1240	1504	1380	—576	3.1	0.9	1.9	—2.6	429	380	403	—434
2	ML	31.9	26.3	29.1	1.9	2265	2372	2322	366	7.1	4.9	5.9	1.4	1576	873	1201	364
3	M	28.7	25.6	27.2	...	1726	2160	1956	...	5.8	3.3	4.5	...	1033	666	837	...
4	MP	34.2	36.7	35.4	8.2	2349	3192	2796	840	8.8	10.6	9.7	5.2	2176	2435	2314	1477
5	MRP	33.8	38.8	36.3	9.1	2506	3347	2951	995	9.4	13.6	11.6	7.1	2432	2811	2634	1797
6	MPK	.....	37.9	.....	.....	.....	3069	.....	.....	.....	12.7	.....	.....	.....	2638	.....	.....
7	MLP	41.8	43.4	42.6	19.6	3324	3559	3449	1607	13.0	17.5	15.4	11.1	2699	3223	2978	2399
8	MLRP	37.9	40.5	39.2	16.2	2825	3369	3113	1271	10.6	13.7	12.2	7.9	2161	2686	2441	1862
9	MPK	...	36.2	...	...	...	2732	...	...	.....	12.0	.....	.....	.....	2186	.....	.....
10	M	23.1	22.8	23.0	.....	1677	1989	1842	.....	5.9	2.9	4.3	.....	377	756	579	.....
11	MLPK	.....	46.7	.....	.....	.....	3739	.....	.....	.....	17.1	.....	.....	.....	3474	.....	.....
12	MRPK	38.1	45.1	41.6	18.6	2782	3711	3274	1432	11.3	16.8	14.2	9.9	3051	3409	3242	2663
13	MLRPK	41.8	50.1	45.9	22.9	3066	3836	3474	1632	11.8	15.9	14.0	9.7	2979	3484	3248	2669

* O = no treatment; M = manure or crop residues; L = limestone; P = superphosphate; RP = rock phosphate; K = muriate of potash or its equivalent. Crop increases for limestone and fertilizer treatments were calculated by subtracting the yield of the nearest manured check plot (Plot 3 or 10). Probably it would be as satisfactory to use an average of the two checks as the basis for calculating increases.

depressing effect on the availability of rock phosphate. The use of lime without a phosphate fertilizer is not advisable.

3. The results for potash are conflicting when soil variation known to exist is taken into consideration. The average of all data (compare Plot 4 with Plots 6 and 9, Plot 7 with Plot 11, and Plots 5 and 8 with Plots 12 and 13) shows an increase for its use, coming largely from the plots where it was used in connection with rock phosphate (Plots 12 and 13). Greater returns from potash may be expected where no manure is used. Its use should be tried on soils of this character as suggested under the heading, "Recommendations," page 410.

4. For the quantities used in this experiment, rock phosphate without lime appears to be more effective than superphosphate without lime. However, the differences are not very significant.

5. Fairly good clover has been grown without lime where phosphate fertilizers have been used. There are no doubt many soils in the Western Coal Field and the surrounding sandstone region on which good clover can be grown without lime if liberal amounts of phosphate fertilizers are used and an adapted strain of seed is sown. However, liming in connection with superphosphate will without doubt be profitable practically anywhere in the region.

For recommendations on soil management and fertilizer practices, see "Recommendations," page 410.

THE TOBACCO ROTATION AND FERTILIZER TESTS

Another rotation is used on this field, in which dark fire cured tobacco is the principal crop. This rotation occupies a better drained portion of the field and was begun in 1914. The land has not been tile-drained. For two years the rotation was tobacco-potatoes-clover, after which wheat was substituted for potatoes. In 1925 a change was begun to a six-year rotation of tobacco, tobacco, wheat, legume and grass mixture for three years. The first tobacco crop following a four-year sod appeared in 1930. The mixture used consisted of bluegrass, redtop and common lespedeza for the first two seedings. Clover and Korean lespedeza were added to the later seedings.

Limestone was used on the first series at the rate of 2 tons

per acre, in 1913 and 1917. On the other two series it was used at the same rate three times between 1913 and 1919.* Screenings one-quarter inch and finer were used.

Superphosphate was used at the rate of 600 pounds per acre for the rotation thru 1920. From 1921 to 1925 the rate was 300 pounds. It was applied broadcast on the tobacco land, except that some of it was used on potatoes for the two years they were grown.

One application of 300 pounds of sulfate of potash per acre, or its equivalent of other potash fertilizers, was made on each series, after which it was used at the rate of 150 pounds for the rotation till 1925, inclusive. It was applied at the same time and in the same way as superphosphate.

Nitrate of soda was used at the rate of 100 pounds per acre on tobacco (200 pounds on Plot 8, one half at topping time) thru 1922, the application being made around the hill after setting. Since 1922 it has been used at the rate of 200 pounds per acre per year, broadcast except as hereafter noted.

From 1926 to 1928 the rates were: superphosphate, 350 pounds; sulfate of potash, 50 pounds; and nitrate of soda, 200 pounds per acre; all applied broadcast for tobacco. One hundred pounds of muriate of potash were applied on potash plots for wheat.

Beginning in 1929, in order to standardize applications on the various fields, the rates were changed to 300 pounds of superphosphate, 100 pounds of sulfate of potash, and 200 pounds of nitrate of soda per acre, on each tobacco crop, with no additional minerals for the other crops of the rotation. Part of this fertilizer was used in the hill and the remainder broadcast, except that the remainder of the nitrate of soda was used as a side-dressing after the plants had made some growth.

Nitrate of soda was used on wheat on plots receiving nitrogen at the rate of 100 pounds per acre as a spring top-dressing thruout the entire period.

No manure was used in this rotation, except on one plot (see discussion). One clover crop, that of 1915, was returned to the plots after harvesting and weighing.

The total applications of the various fertilizing materials

* Thru error the total amount of limestone used in this rotation was stated in Bulletin 272 as 4 tons per acre.

are equivalent to annual applications of approximately the following amounts:

Superphosphate	160 lbs.
Sulfate of potash, or equivalent	60 lbs.
Nitrate of soda on tobacco	150 lbs.

Tobacco stalks were returned to the wheat plots up to 1926, except one year when they were used on the tobacco land. Wheat straw was returned to the clover sod from 1921 to 1923.

Table 10 gives the fertilizer treatments and crop yields in this rotation, except for the modified treatments shown in Table 11.

Changes were made in treatment as follows in 1915 and 1916: Plot 2, originally treated with limestone and potash, was changed by including superphosphate. Plot 4, originally untreated, was changed to superphosphate and nitrogen. Plot 5, originally limestone, potash and nitrogen, was used for a check plot, as these materials had little or no effect on yields in the absence of a phosphate fertilizer. White Burley tobacco was grown on plot No. 9 thru 1921. Dark tobacco has been used since. Yields for these amended treatments up to 1925 will be found in Bulletins 228 and 272. Only the second period is included in this report.

The first wheat crop appeared in this rotation in 1917 but is omitted from the averages because the clover preceding the wheat did not receive the amended treatments. The averages for other plots were but little affected by omitting this crop. The crop of 1924 was winterkilled, and there was no crop in 1926 because wet weather prevented seeding wheat in 1925. With change to a six-year rotation, wheat appears in alternate years, consequently there was no wheat in 1927 and 1929.

In 1926 lespedeza was the only legume in the hay mixture and the only plant that made sufficient growth for harvest. There was no clover crop for 1928 and 1930 because of change of rotation, but the plots from which hay was harvested each of those years contained clover the previous year. The two-year average is given in the last column of Table 10. In farm practice such grass lands could be grazed more advantageously than to use them for hay.

Table 10. Yields Per Acre of Crops in Tobacco Rotation. Greenville Soil Experiment Field.

Plot No.	Treatment*	Tobacco, Lbs. Ave. 17 Crops					Wheat, Bus. Ave 9 Crops	Clover Hay, Lbs. Ave. 13 Crops					Lespedeza Hay, Lbs. 1926 Crop	Grass Hay, Ave. 2 Crops
		First Period	Second Period	Both Periods	Increase			First Period	Second Period	Both Periods	Increase			
					Both Periods	Second Period					Both Periods	Second Period		
1	LP	984	803	889	496	429	20.0	3905	3304	3582	2890	2693	3190	2665
2	LPK	.....	929	.....	.....	555	20.1	.....	3524	.....	.....	2913	3240	2850
3	LPN	949	836	889	496	462	21.1	3907	3376	3621	2929	2765	2900	2505
4	PN	.....	829	.....	.....	455	17.4	.....	2261	.....	.....	1650	2480	2320
5	None	455	374	393	.....	.....	7.2	785	611	692	.....	.....	690	715
6	LPKN	1052	956	1001	608	582	20.9	3928	3036	3448	2756	2425	2790	2150
7	PKN	1085	977	1028	635	603	19.4	3422	2561	2958	2266	1950	2620	2310
8	LPKN	1018	896	953	560	522	18.2	3513	2667	3058	2366	2056	2670	1610
9	LP	———	819	———	———	445	18.2	———	3103	———	———	2492	3760	3135

* L = limestone; P = superphosphate; K = sulfate of potash or its equivalent; N = nitrate of soda.

When these experiments were laid out, the importance of more frequent check plots and replications of treatments was not fully appreciated. To overcome, in part, these defects by providing repetition of treatments most of the plots (originally one-tenth acre) in the tobacco rotation were divided into two twentieth-acre plots, beginning with the tobacco crop of 1928. The first half of each plot retains the old number and receives the original treatment. The second half, designated by "a", has been modified as will appear in Table 11, which gives the average yield of tobacco for three years.

Table 11. Average Yields of Tobacco for Three years—Modified Treatments.

Plot No.	Treatment	Ave. Yield 3 Years
1	LP	890
2	LPK	1017
2a	LPKN	1057
3	LPN	853
3a	LP(2K)N	927
4	PN	867
4a	PKN	883
5	None	437
5a	None	468
6	LPKN	1040
6a	LPK	877
7	PKN	917
7a	PK	783
8	LPKN	843
8a	LPK	720
9	LP + Tobacco stalks, 300 lbs. per acre	850
9a	LP + 10 tons manure on each crop	1243

DISCUSSION OF RESULTS IN THE TOBACCO FERTILIZER TESTS

Potash produced a good increase in tobacco when used in a complete fertilizer (compare Plot 5 with Plots 2a, 3a, 6 and 8; also Plot 4 with Plots 4a and 7).

Nitrogen has produced a good increase in tobacco when used in a complete fertilizer (compare Plot 2 with Plot 2a, Plot 6 with 6a, Plot 7 with 7a, and Plot 8 with 8a).

Potash when used in addition to limestone and superphosphate, without nitrogen, shows no increase when Plot 1 is compared with an average of Plots 2, 6a and 8a, but shows a large increase when Plot 1 is compared with Plot 2. Nitrogen used in addition to limestone and superphosphate without potash gave no increase (compare Plot 1 with Plot 3). Limestone and complete fertilizer show a fair increase over limestone and super-

phosphate when Plot 1 is compared with an average of Plots 2a, 3a, 6 and 8, and a large increase when compared with Plot 2a. The most effective treatment for the last three years was limestone, superphosphate and 10 tons of manure per acre (Plot 9a). The results obtained on the last three tobacco crops by duplication of treatments are in fair agreement with the results for the longer period.

The following conclusions in regard to the fertilization of tobacco appear warranted by the results for the whole period:

1. Limestone has had no beneficial effect on tobacco on this soil, except, possibly, in the later years after considerable time had elapsed since limestone was used. This is probably due in part to the use of too much of the material. This soil is not strongly acid, and fairly good clover was grown without liming. Probably two tons per acre, applied at the beginning of the work, would have been sufficient for the entire period. When limestone is used on land on which tobacco is to be grown, the applications should be no larger than necessary to produce clover, and should not be made immediately preceding the tobacco crop. Tobacco is benefited thru the legume, not directly by the limestone. Unless the soil is more acid than most soils on which tobacco is grown in Kentucky, not more than 2 tons per acre may be used safely, and then only when applied as suggested.

2. A profitable growth of crops cannot be produced on this soil without a liberal use of phosphate fertilizers.

3. Potash and nitrogen in the fertilizer are profitable for tobacco under the conditions of these tests. However, the results do not furnish sufficient information to justify drawing conclusions regarding the best fertilizer analysis or the most profitable amount to use.

4. The tobacco produced on the variously treated plots was rated for quality each year. The ratings show that the complete fertilizer produced leaf of significantly better quality than any other treatment. The quality was better where limestone was not used. Superphosphate and potash have produced a better quality of tobacco than superphosphate on limed soil, while nitrogen in addition to superphosphate produced no sig-significant effect on quality.

For recommendations on soil management and fertilizer practices, see page 410.

THE MAYFIELD SOIL EXPERIMENT FIELD

Harry Wilson, Foreman

The Mayfield Soil Experiment Field* was established in 1913. It lies about two miles southwest of Mayfield in Graves County. The soil is yellow silt loam of the undulating area (see Agricultural Experiment Station Bulletin No. 194, "Soils of Graves County"), which is the most important area of farming land in Graves County, and fairly represents the upland soils of the Purchase Region. It is probably the Memphis silt loam of the United States Bureau of Soils. An analysis of the surface soil of this field at the time work was begun gave the following results, stated as pounds in 2,000,000 pounds of soil (the weight of an acre to the depth of about 7 inches):

Total nitrogen	1,920 lbs.
Total phosphorus	960 lbs.
Total potassium	29,700 lbs.

The soil is acid (pH 4.9)

THE FOUR-YEAR ROTATION

Two rotations were used on this field. One consisted of corn (rye cover crop), soybeans, wheat and clover. Winter oats were used in the place of soybeans in 1914 and 1915. There are five series of plots on the part of the field occupied by this rotation. The first and fifth series were used as duplicates; that is, the same crops were grown upon them, except for the period 1913-16, when the fifth series was in grass, and 1924-29, when the first series was used for cotton tests. It was intended originally to have grass as an addition to the rotation, but the plan was changed, beginning with 1917.

Limestone was used at the rate of 2 tons per acre per rotation for two rounds of the rotation, 1913-1920. It was applied on the series for corn, except that fractional applications were used on the other series the first year, as at Berea. These applications amounted to an average of 4.6 tons of limestone per

* The land for this experiment field was provided by Graves County, whose helpful cooperation is hereby acknowledged.

acre in 18 years. The limestone was screenings of ¼ inch and finer.

Superphosphate was used at the rate of 800 pounds per acre for the four-year rotation for two rounds of the rotation, after which the rate was reduced to 400 pounds. Rock phosphate was used at double the rate of superphosphate.

Muriate of potash, or its potash equivalent, was used at the rate of 400 pounds per acre the first three years and 200 pounds per acre since.

All the fertilizers were applied on the corn ground in the full amount for the rotation until 1924-26, when the applications were changed to the wheat ground, except that fractional applications were used the first year as with limestone. Plot 9 is an exception to this statement. On this plot the superphosphate application for the rotation was divided into three equal parts and applied on the first three crops of the rotation thru 1920. These fertilizers were applied on the broken ground and disked into the soil until the change was made to wheat, except that the rock phosphate usually was applied before breaking.

Nitrate of soda was used at the rate of 100 pounds per acre on corn, except that dried blood was used instead of nitrate of soda for the first three years and in addition to it for the next two years. About half the years these nitrogen materials were applied broadcast with the other fertilizers, and the remainder of the time around the hill, between planting time and the second cultivation. The hill applications were mostly in the second period (see Table 12). Nitrate of soda was used on wheat at the rate of 100 pounds per acre, applied at the beginning of spring growth.

The total applications of limestone and the various fertilizing materials are equivalent to annual applications of approximately the following amounts:

Limestone	505 lbs.
Superphosphate	160 lbs.
Rock phosphate	320 lbs.
Muriate of potash, or its equivalent	65 lbs.

Cowpeas were grown on Series 200 in 1913 instead of clover, and were turned under for the corn crop of 1914. Manure was used at the rate of 6 tons per acre on the corn land on all plots

except Nos. 1 and 10 from 1916 to 1919, inclusive. No manure was used in 1920. Since then it has been applied to the corn plots receiving manure at a rate equal to the weight of the crops removed from the corresponding plots the preceding year (wheat grain excepted), except in 1927 and 1928 when it was used at a uniform rate equal to the average weight of crops removed from the check plots the preceding year.

Plot No. 1 did not receive manure or crop residues. From 1916 to 1919, inclusive, cornstalks and straw were returned to Plot 10. Since then no manure or residues have been returned to this plot, which is used in comparison with Plot 9 to measure the effect of manure.

The corn crop of 1919 was ruined for experimental purposes by cattle that broke into the field. The crop was almost a failure in 1930 on account of drouth, and is not included in the averages. Soybeans were not introduced into the rotation until 1916. Before then, winter oats occupied the second year in the rotation. Wet weather in the falls of 1919 and 1925 prevented seeding wheat.

The first clover crop harvested was in 1916. The stand and growth of clover in 1915 was poor, and the crop was left on the ground for the benefit of the succeeding corn crop. The crops of 1923 and 1926 were failures. In 1926 soybeans for hay were substituted.

Other plants have been included with the clover as follows (year of harvest given) for the purpose of observation on adaptability to different conditions (see page 360):

1916	Orchard grass and tall meadow oat grass
1917	Sweet clover and timothy
1918–19	Sweet clover
1921	Timothy
1925	Timothy
1926	Common lespedeza and timothy
1927	Common lespedeza, timothy and alfalfa
1928	Common and Korean lespedeza, timothy and alfalfa

Beginning with 1925 all additions have been retained to the present.

The crop yields for the various fertilizer treatments in the four-year rotation are given in Table 12.

Since timothy, alfalfa and lespedeza were introduced into the hay mixture on this field some important results have been

Table 12. Average Crop Yields Per Acre in the Four-Year Rotation. Mayfield Soil Experiment Field.

Plot No.	Treatment*	Corn, Bus., Ave. 16 Crops				Soybean Hay, Lbs., Ave. 15 Crops				Wheat, Bus., Ave. 15 Crops				Clover Hay, Lbs., Ave. 13 Crops			
		First Period	Second Period	Both Periods	Increase Due to Treatment†	First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment	First Period	Second Period	Both Periods	Increase Due to Treatment
1	O	23.1	26.8	24.9	—5.7	1765	1956	1867	—451	5.4	3.2	4.3	—2.0	437	841	655	—144
2	ML	32.3	47.1	39.7	9.1	2885	3038	2966	648	9.5	11.9	10.8	4.5	2243	2884	2588	1789
3	M	27.2	34.0	30.6	.....	2256	2373	2318	.....	6.9	5.8	6.3	.....	553	1010	799	.....
4	MP	27.9	38.2	33.1	1.4	2617	2583	2599	234	9.2	10.2	9.7	2.9	924	1680	1331	468
5	MRP**	31.8	44.1	37.9	5.2	2856	3034	2951	540	8.8	13.6	11.2	4.0	1375	3201	2359	1432
6	MLP	39.6	53.4	46.5	12.7	3542	3369	3450	993	15.3	20.0	17.8	10.2	3265	4163	3748	2756
7	M	27.6	41.9	34.8	.....	2389	2606	2504	.....	8.6	7.7	8.1	.....	522	1514	1056	.....
8	MLRP	39.9	53.1	46.5	11.9	3595	3476	3531	955	17.3	18.5	17.9	9.8	3242	3940	3618	2502
9	MLP	34.5	51.9	43.2	8.8	3521	3643	3586	938	16.7	22.4	19.7	11.6	3426	4119	3799	2624
10	LP	34.8	39.5	37.1	2.8	3498	3389	3440	721	15.5	17.7	16.7	8.6	3178	3524	3364	2130
11	M	28.8	39.4	34.1	.....	2598	2960	2791	.....	8.3	8.0	8.1	.....	746	1764	1294	.....
12	MK	30.0	39.4	34.7	—0.4	2737	2692	2713	—120	10.3	9.0	9.6	1.4	961	1243	1113	—237
13	MLK	39.2	55.4	47.3	11.2	3841	3609	3718	843	14.3	19.1	16.9	8.6	2953	3810	3415	2009
14	MLPK	41.1	59.3	50.2	13.1	4136	3893	4007	1089	18.4	24.7	21.8	13.5	4038	4807	4452	2990
15	M	32.7	43.4	38.1	.....	2825	3078	2960	.....	8.7	8.2	8.4	.....	1420	1601	1518	.....
16	MLRPK	40.2	54.4	47.3	9.2	3757	3861	3812	852	12.6	17.9	15.4	7.0	3593	4354	4003	2485
17	MLPKN	37.3	56.0	46.6	8.5	3751	3964	3865	905	16.1	24.3	20.5	12.1	3660	4729	4235	2717

* M = manure; L = limestone; P = superphosphate; RP = rock phosphate; K = potash; N = nitrate of soda.
** This plot is on low richer ground on series 100. The yields on this plot have been corrected, using the ratio between Plots 4 and 5 on the other four series.
† Variation method of computing increases used on plots lying between check plots. (Plots 3, 7, 11 and 15. See page 357.)

obtained. Table 13 shows hay yields in 1927 and in 1929 on the regular series for hay and on the series on which the mixture was sown on the wheat in the spring of the latter year. The hay obtained from the extra cuttings is not included in the general average yields of hay in Table 12.

Table 13. Hay Yields Per Acre, Mayfield Experiment Field, 1927 and 1929.

Plot No.	Treatment	1927 (1926 Seeding)			1929				
					1928 Seeding				
		First Cutting	Second Cutting	Both Cuttings	First Cutting	Second Cutting	Both Cuttings	1929 Seeding	Total for Year
1	O	1070	1850	2920	550	2120	2670	.....	2670
2	ML	4650	1790	6440	2380	1000	3380	580	3960
3	M	950	1930	2880	900	970	1870	.....	1870
4	MP	2240	2170	4410	1950	3890	5840	.....	5840
5	MRP	2470	1520	3990	5000	5790*	10790	.....	10790
6	MLP	4450	2150	6600	5450	1200	6650	1130	7780
7	M	1110	1440	2550	1700	1870	3570	.....	3570
8	MLRP	4450	2020	6470	5050	1550	6600	1370	7970
9	MLP	4650	2220	6870	5150	1600	6750	1790	8540
10	LP	4250	1330	5580	3800	700	4500	970	5470
11	M	1220	1650	2870	1960	3210	5170	.....	5170
12	MK	1320	1950	3270	1500	3690	5190	.....	5190
13	MLK	5800	3010	8810	3750	1750	5500	1920	7420
14	MLPK	5650	3720	9370	5250	2150	7400	2370	9770
15	M	520	1510	2030	2770	3840	6610	.....	6610
16	MLRPK	5150	2320	7470	5160	1650	6810	1520	8330
17	MLPKN	4650	2200	6850	5960	2550	8510	2020	10530

* Much crab grass.

For the first crops on all plots that were not limed the hay was chiefly grass. On limed plots it was chiefly alfalfa and clover. For the second crop on the unlimed plots the hay was lespedeza. On the limed plots it was alfalfa and clover. The new seeding for 1929 produced no hay except where lime was used. This hay was chiefly clover.

TOBACCO ROTATIONS AND FERTILIZER TESTS

On this field are a number of tobacco rotations and fertilizer tests which were run until 1929, when certain changes were made in the rotations to be mentioned later.

Rotation No. 1 was tobacco, wheat and clover, or a clover and grass mixture (same mixture 1926-29 as in 4-year rotation). It occupied the first six plots of each series which received the

various treatments shown in Table 14. Winter oats was used instead of wheat on Plot 6 until 1917.

Rotation No. 2 (Plot 7) was tobacco, winter grain, and a mixture of orchard grass and common lespedeza for the third-year crop. (Grass and lespedeza were a year later in being established than the hay crop in other rotations.)

Rotation No. 3 (Plot 8) was tobacco, winter grain and sweet clover.

Rotation No. 4 (Plot 9) was tobacco, winter grain and common lespedeza.

In rotations 2, 3 and 4 a winter grain cover crop was used until 1921, and was clipped in the spring to prevent its maturing. Since then wheat for grain has been used. The average yields of wheat in these three rotations are given for only the second period.

In rotation No. 2 the orchard grass made small growth. Only the yields of lespedeza hay for the second period are given for this rotation.

In 1929 a beginning was made toward changing all these rotations to a six-year rotation consisting of (1) tobacco, (2) tobacco (rye cover crop between tobacco crops), (3) wheat, (4), (5) and (6) grass and legume hay. The 1931 tobacco will follow a two-year-old clover and grass sod, and the 1933 crop a three-year-old sod. The tobacco crops of 1929-30 followed a sod of the three-year rotations referred to previously. Manure was used on all tobacco plots in 1929 and 1930 at the rate of 5 tons per acre the first year and 6 tons the second year. Its use will be continued in this rotation. The fertilizer treatment on Plot No. 7 was changed from superphosphate to complete fertilizer. The average of the last two crops is presented separately in Table 14.

Limestone was used at the rate of 2 tons per acre three times between 1913 and 1919.*

Superphosphate was used at the rate of 600 pounds per acre for the rotation from 1914 to 1920, and 300 pounds per acre from 1921 to 1925, applied broadcast on the tobacco land.

Sulfate of potash, or its potash equivalent, was used at the rate of 300 pounds per acre for the initial application on

* Thru error the total amount of limestone used in this rotation was stated in bulletin No. 272 as 4 tons per acre.

each series and for the second application on Series 700, after which it was used at the rate of 150 pounds for the rotation until 1925. It was applied at the same time and in the same way as superphosphate.

Nitrate of soda was used at the rate of 100 pounds per acre on tobacco until 1922, the application being made broadcast, except in two years when it was used as a side-dressing soon after setting the crop. Beginning with 1923, it has been used at the rate of 200 pounds per acre, broadcast, except as hereafter noted.

From 1926 to 1928 the application per acre on tobacco was superphosphate 350 pounds, sulfate of potash 50 pounds, and nitrate of soda 200 pounds, all applied broadcast. On wheat following tobacco during these three years 100 pounds of muriate of potash were used.

Beginning in 1929, in order to standardize the applications on various fields, the rates were changed to 300 pounds of superphosphate, 100 pounds of sulfate of potash, and 200 pounds of nitrate of soda on each tobacco crop, with no additional minerals to the other crops of the rotation. Part of this fertilizer was used in the hill and the remainder broadcast, except that the remainder of the nitrate of soda was used as a side-dressing.

Nitrate of soda was used on wheat on plots receiving nitrogen at the rate of 100 pounds per acre thruout the period.

The total applications of the various fertilizing materials are equivalent to annual applications of approximately the following amounts:

Superphosphate	160 lbs.
Sulfate of potash, or equivalent	65 lbs.
Nitrate of soda on tobacco	150 lbs.

The first tobacco crop (1914) was a failure due to a dry period at setting time. The crop of 1919 was a failure for the same reason. The crop of 1922 was destroyed by fire in the barn.

The first wheat crop was in 1914. Wheat could not be seeded for the crops of 1920 and 1926 because of wet weather.

There was no wheat in 1930 because of the change to the six-year rotation previously mentioned, in which wheat appears only in alternate years.

A clover crop was turned under for tobacco in 1915. There

Table 14. Yields of Crops Per Acre in Tobacco Rotations, Mayfield Soil Experiment Field.

Rotation No.	Plot No.	Treatment*	Tobacco, Lbs. Average 14 Crops					Wheat, Bus. Average 14 Crops					Hay, Lbs. Average 13 Crops				
			First Period	Second Period	Both Periods	Increase Both Periods	Ave. Last 2 Crops	First Period	Second Period	Both Periods	Increase Both Periods	Increase Second Period	First Period	Second Period	Both Periods	Increase Both Periods	Increase Second Period
	1	P	748	953	851	214	960	15.3	10.8	13.0	6.6	6.5	1985	1328	1631	603	463
1	2	LP	1005	865	935	298	1121	23.4	20.8	22.1	15.7	16.5	4292	3024	3609	2581	2159
	3	None	566	708	637	..	773	8.4	4.3	6.4	..	..	1217	865	1028	..	..
	4	LPK	923	952	937	300	1051	19.0	17.5	18.3	11.9	13.2	3896	3458	3568	2540	2593
	5	LPKN	1053	1210	1131	494	1242	22.8	22.1	22.5	16.1	17.8	4519	3763	4112	3084	2898
	6	LPN	1036	1058	1047	410	1088	.. ..	21.5	.. ..	.. ..	17.2	4325	3815	4059	3031	2950
2	7	P (KN)**	795	947	871	234	1163	.. ..	12.9	.. ..	.. ..	8.6	.. ..	2491	..	..	1626
3	8	LP	925	973	949	312	1080	.. ..	19.8	.. ..	.. ..	15.5	4950	3813	4337	3309	2948
4	9	P	1045	974	1010	373	1071	.. ..	12.1	———	———	7.8	2139	2274	2212	1184	1409

* See Table 12 for symbols.
** Complete fertilizer used for last two crops of tobacco on Plot 7; superphosphate previously.

was no clover crop in 1919, due to dropping an old series of plots and bringing in a new series to take its place. The first series of plots was abandoned because of too great differences in the natural productiveness of the soil. Three series were made of the other two by shortening the plots. The crop of 1926 failed, and soybeans were grown instead.

The results of the tobacco rotations are given in Table 14.

DISCUSSION OF RESULTS

It is evident from an inspection of the results that limestone is very effective on this soil in increasing the yield of all crops, with the possible exception of tobacco. Comparing all treatments containing limestone, in both rotations, with treatments similar except for limestone, the average annual increases for limestone were as follows:

Corn	9.2	bus.
Soybean hay	690	lbs.
Wheat	6.5	bus.
Clover hay	1,800	lbs.

Limestone was not very effective on tobacco (see Table 14). In the second period the yield with superphosphate in rotation No. 1 was greater than with limestone and superphosphate, altho the yields of wheat and clover were very much greater with limestone and superphosphate. The tobacco yield following lespedeza in rotation No. 4, in which superphosphate alone is used, is decidedly greater for the whole period than in the sweet clover rotation (No. 3), on which limestone was used with superphosphate, altho excellent yields of sweet clover were grown and wheat yields were very much greater than in the lespedeza rotation. (For further discussion of the relation of lime to tobacco, see recommendations on page 412.)

Superphosphate on unlimed soil was not very effective in the four-year rotation (Plot 4, Table 12). Rock phosphate was more effective on unlimed soil (Plot 5) than superphosphate. Where these two phosphates were used in comparison on limed soil, the following increases are found above limed soil without the phosphates:

	Superphosphate	Rock Phosphate
Corn	1.8 bus.	0.4 bus.
Soybean hay	282 lbs.	158 lbs.
Wheat	5.7 bus.	1.9 bus.
Clover hay	941 lbs.	595 lbs.

Superphosphate and the combination of limestone and superphosphate were fairly effective on tobacco (Table 14). Attention is called to rotation No. 2 (Plot 7) and rotation No. 4 (Plot 9). The failure of tobacco to yield as well in rotation No. 2 (Plot 7) as in No. 4 (Plot 9) in the first period is probably due to variation in the natural fertility of the two sets of plots.

When all treatments which contain potash, in both rotations, are compared with treatments similar except for potash (Plot 12 not used), it is found that the average increase is small except for tobacco. In some of the comparisons the increase for potash is fairly good, as, for example, between Plots 9 and 14 in the four-year rotation, while in others there is no increase, as in Plots 8 and 16. Soil variation is too great in these tests to make small differences between treatments significant. When used in a complete fertilizer, potash was effective on tobacco (compare Plots 5 and 6, Table 14). Potash should be tried on soils of this character as suggested under the heading, "Recommendations," page 410.

There was only one test with nitrogen (Plot 17) in the four-year rotation, and these plots do not show any increase over Plot 14 with which they are to be compared. The plots on which nitrate of soda was used are on somewhat poorer ground in some of the series. In the tobacco rotation nitrate of soda seems to be effective on tobacco and hay. The effect on wheat seems to be considerable when Plots 4 and 5 are compared, but in comparing Plot 2 with Plots 5 and 6 the differences are small. Because of insufficient check plots, it cannot be determined what part soil variation plays in the results.

Price ratings obtained on part of the crops show the tobacco grown with complete treatment to be of better quality than that grown on the check plot or with any other treatment, altho the differences are not great.

Comparing Plot 1 (without manure) with Plot 3 (with manure) of the four-year rotation for the second period, the increases for manure are as follows:

Corn	7.2	bus.
Soybean hay	417	lbs.
Wheat	2.6	bus.
Clover hay	169	lbs.

Comparing Plot 9 (with manure) directly with Plot 10 (without manure), there are the following increases for manure:

Corn	12.4	bus.
Soybean hay	254	lbs.
Wheat	4.7	bus.
Clover	595	lbs.

Limestone and superphosphate on Plot 9 increased the amount of manure to be used and thereby produced greater crop increases for manure than on Plot 3.

The manure used in these experiments was purchased and was no doubt inferior to manure which could have been made by feeding the crops grown on the field.

For recommendations on soil management and fertilizer usages, see page 410.

THE COTTON TESTS

Cotton growing is of some importance in the Purchase region, particularly in Fulton and Hickman counties. Fertilizer tests were conducted with cotton from 1924 to 1929 on Series 100, a duplicate of Series 500 of the four-year rotation (corn-soybeans-wheat-clover). The third round of the rotation was completed when the cotton tests were begun. The land had had two applications of limestone on the limed plots, and three applications of fertilizers on the variously fertilized plots, according to the rates and manner of application named on page 398. All plots, except No. 1 and No. 10, had received manure in 1917 and again in 1921. Clover intended for harvest in 1924 was plowed under for the first cotton crop. Manure was not used again.

Beginning with the second crop, the series of plots was divided into two series, and cotton alternated on the two series in rotation with soybeans or cowpeas. These crops were plowed

under in the years preceding the 1926 and 1927 crops and were removed for hay thereafter. Rye was sown as a winter cover crop each year.

Fertilizers were used only on the 1924, 1926 and 1927 cotton crops. The amounts used were such as to give an average annual rate per acre, for the 6 years, of superphosphate, 100 pounds; rock phosphate, 200 pounds; muriate of potash, 50 pounds. Nitrate of soda was used on cotton at the rate of 100 pounds per acre the first year and 200 pounds for each of the succeeding crops. All fertilizers were applied broadcast, except nitrate of soda which was applied along the sides of the rows after the cotton was thinned. Its use on Plot 9 was begun with the second crop. The yields are given in Table 15.

Table 15. Yield of Seed Cotton, Pounds Per Acre. Mayfield Soil Experiment Field.

Plot No.	Treatment*	1924	1925†	1926	1927	1928	1929	Ave. 6 Crops	Increase Due to Treatment
1	None	205	148	790	320	378	230	345	—81
2	LM	480	232	960	430	500	200	467	41
3	M	470	222	910	290	442	220	426	------
4	PM	480	528	990	560	426	460	574	152
5	RPM	555	696	1020	***	500	400	634	(5 yr. ave.)
6	LPM	430	549	1130	600	548	420	613	199
7	M	480	158	870	330	350	270	410	------
8	LRPM	650	306	1100	500	476	390	570	134
9	LPNM	**725	390	1250	500	872	600	723	261
10	LP	740	633	900	510	692	780	709	222
11	M	605	295	850	360	406	560	513	------
12	KM	740	232	760	390	502	600	537	—5
13	LKM	1130	380	1350	520	794	840	836	265
14	LPKM	1485	760	1620	920	956	1220	1160	561
15	M	795	317	1080	410	568	600	628	------
16	LRPKM	1320	506	1610	680	946	970	1005	377
17	LPKNM	1485	549	1740	880	998	1320	1162	534

* O = no treatment; M = manure; L = limestone; P = superphosphate; RP = rock phosphate; K = potash; N = nitrate of soda.

** Use of nitrogen not begun until the 1925 crop, on Plot 9.

*** Stand on Plot 5 was drowned out in 1927.

† Cotton picked but once in 1925; continued wet weather prevented further picking. Use of these figures reduces the average somewhat.

Variety tests with cotton were conducted for three years, 1924-1926. The results of the tests the first two years were reported in Bulletin 272. Results for the third year were in keeping with those of the two preceding years and for that reason are not reported here.

Fertilizers for Cotton

Cotton is a crop that responds well to liberal fertilization. Results of the fertilizer tests indicate that a high percentage of potash in the fertilizer is especially effective. From 300 to 500 pounds of a fertilizer carrying 3 percent of nitrogen, 10 percent of phosphoric acid, and 8 to 10 percent of potash is suggested. A side-dressing of 75 to 100 pounds of a soluble nitrogen fertilizer when the cotton is thinned may also be profitable on land of medium to low productiveness.

THE LONE OAK SOIL EXPERIMENT FIELD

J. W. Lilley, Foreman

The Lone Oak Soil Experiment Field* is located in McCracken County, about 4 miles southwest of Paducah, near Lone Oak. Work was begun on it in 1913, the same time as on the Mayfield field, and was of the same general plan except that tobacco was not grown.

At the end of 1923, plot work was discontiued for the purpose of trying methods of eradication of wild onions with which the field was badly infested when the land was acquired and which the tillage operations connected with the work did not eradicate.

The results of the fertilizer tests were published in Bulletin No. 272. They were very much the same as at Mayfield. For all practical purposes the results of the Mayfield field may be applied to the soils represented by the Lone Oak field.

The wild onion eradication tests were concluded in 1927. The results have been issued in the form of a mimeographed circular which may be had free upon application to the Agricultural Experiment Station.

Since the results on this field were so similar to those of the Mayfield field, it was decided to discontinue the fertilizer tests and use the land for other purposes. A part of the land now is used for a four-year rotation of corn, wheat, and alfalfa for two years. Another part is used for a two-year rotation of corn and wheat, with sweet clover sown on the wheat. This is turned under, after considerable spring growth, for corn.

---

* The land for this field was provided by McCracken County, whose helpful cooperation is hereby acknowledged.

A steep part of the field which had not been used for plot work and which was subject to severe erosion, was terraced and seeded to a mixture of pasture grasses as a demonstration in using such land for pasture.

It is believed that this work will be of interest in this region, where dairying and other livestock enterprises are developing.

THE HOPKINSVILLE EXPERIMENT FIELD

The Hopkinsville Experiment Field, work on which was begun in 1922, was discontinued at the end of the cropping season of 1929. The results of this work have been published in Bulletin No. 299 of the Experiment Station, which may be had free upon application. The work dealt specifically with the problem of increasing wheat yields in the region.

RECOMMENDATIONS ON SOIL MANAGEMENT AND FERTILIZER PRACTICES

For the types of soil in Kentucky represented by the soil experiment fields reported on in this bulletin the best soil management and fertilizer practices are believed to be embodied in the following recommendations. They are applicable to practically all soils of the state except the high-phosphate soils of the Bluegrass area and some of the better river-bottom soils.

1. *Rotations.* A rotation of crops should be used which includes one legume crop in a two to four-year rotation. If the rotation is made longer by adding grass, a legume should be contained in the grass mixture. The choice of the legume will depend upon the productivity and treatment of the soil, and in part upon the use to be made of it. For hay, the seeding of a mixture containing two or more legumes and a small amount of grass is good practice. Grass and lespedeza make a good mixture where pasture is desired for one or more years following the hay crop.

The crops in the rotation should be such that the land is occupied with growing crops as much of the time as possible, to prevent erosion and leaching. They should also be such as reduce plowing and the seeding of special cover crops to a minimum.

2. *Use of Manure and Legumes.* As much manure should be produced and carefully saved as good management of the livestock permits. The amount of manure that can be saved depends upon the methods of feeding, pasturing and housing. If all feeding is done under cover, sufficient bedding used, and animals are kept under cover when pastures should not be used, it is not difficult to save a ton of manure for each ton of feed and bedding. One and one half tons of manure for each ton of feed and bedding used is possible when sufficient bedding is used and all excrement is saved.

None of the legumes will greatly increase the nitrogen content of medium to good soil unless they are pastured, left on the ground or fed and the manure made by feeding them returned to the soil. Where soybeans and cowpeas are removed from the soil, without return of manure, the nitrogen content of the soil may be lowered. If the manure made from feeding them is returned, more nitrogen may be added to the soil than is withdrawn. Usually manure is used most profitably on corn and tobacco land. All pasture mixtures must contain legumes in order to maintain sufficient nitrogen to meet the needs of the grass. Most of the potash of feeds consumed is voided in animal excrements. If manure is not conserved and returned to the cropped soil, sooner or later potash deficiency may be expected. This deficiency may be hastened by the growing of legumes.

3. *The Use of Liming Materials.* Most of the soils of the state need liming. Some exceptions are found in the hill region of northern Kentucky and in the vicinity of marl deposits. On most of the acid soils of the state, yields of the so-called acid-tolerant legumes, soybeans, cowpeas and lespedeza, usually are increased profitably by the use of lime.

The most acid of the experiment field soils are those of the Berea and Fariston fields. On the least acid, that of the Campbellsville field, the use of limestone has been profitable. An initial application of one to two tons an acre of ground limestone, or its equivalent in marl or burned lime, is usually sufficient on most of the acid soils of the state. However, a minimum of 2 tons is recommended for alfalfa. Reliming should be done only when there is evidence of the need for it. On most soils 2 tons per acre of limestone or its equivalent will

be effective for 8 to 10 years. The need for reliming may be tested by reliming a small area preceding a legume crop and noting the effect.

Except on the Mayfield field, limestone without a phosphate fertilizer has not been very effective. The use of some fertilizer containing phosphate is recommended in addition to liming.

On land on which tobacco is to be grown, only moderate applications of a liming material should be used, and it should be applied immediately following the tobacco crop, not immediately before it. There is no evidence in any of the experimental work of the Experiment Station that liming directly benefits tobacco; in fact there is evidence of lowering of yields and evidence of injury to quality by liming too heavily. There is, however, evidence of much improvement from liming thru its effect on legumes in the rotation. This experience should not deter farmers from using liming materials on tobacco land, but they should be careful as to the amount used and the method of using it. Where too much has been used on tobacco land, its injurious effects may be overcome to some extent by liberal fertilization with high-grade complete fertilizer.

Where liming materials are expensive on account of long hauls or other causes, it is recommended that a mixture of 2 parts of ground limestone or hydrated lime and 1 part of superphosphate or other fertilizer containing a liberal amount of phosphate be drilled in with small grain at the maximum capacity of the drill. This should greatly benefit the clover and grass mixtures sown on the small grain. The mixture should first be tried on a small scale. The practice is giving excellent results in many parts of the state. It is especially recommended on land on which tobacco is to be grown. It will be necessary to repeat the treatment before each legume crop for a few years. The plan has the merit of enabling the farmer to grow legumes on a large area with a small outlay for liming materials.

Many county agents are prepared to test soils for lime and phosphorus needs and are glad to render the service.

4. *The Use of Phosphate Fertilizers.* Phosphate fertilizers have been effective on both limed and unlimed soil on all the outlying fields except at Mayfield, where, in the four-year

rotation, superphosphate has not been very effective on unlimed ground.

It is suggested that 300 to 400 pounds per acre of superphosphate or its equivalent of other phosphate fertilizer be used on the small-grain crop on which will be sown a legume and grass mixture of the character desired for hay or pasture. Much land in the state is so slightly acid that good yields of clover and other legumes can be grown without liming, if phosphate fertilizers are used liberally and adapted strains of red clover are sown. Many clover failures are due to the use of unadapted clover seed of foreign origin or from certain regions in the United States. There is reason to believe that at least some of the clover failures reported on the various fields were caused by the use of unadapted seed. In some years clover was as good, or nearly as good, on fertilized but unlimed plots, on some fields, as on limed plots similarly fertilized. It is believed that adapted seed was a greater factor in these instances than seasonal conditions.

On the Campbellsville and Fariston fields, the use of limestone with rock phosphate resulted in smaller yields than the use of rock phosphate alone, except for soybeans and clover on the Fariston field in the second period. On all of the outlying experiment fields rock phosphate was generally as effective on unlimed soil as half its weight of superphosphate, or more so. On none of the fields was rock phosphate more effective on limed soil than half its weight of superphosphate. Steamed bone meal (at Fariston) and basic slag (at Campbellsville) were both found to be effective. Where rock phosphate is used, it is recommended that enough be applied at one time to serve for a rotation (800 to 1000 pounds per acre) and that it be thoroly incorporated with the soil.*

5. *The Use of Complete Fertilizers on Grain and Hay Crops.* If a phosphate fertilizer has been used for grass and clover, as recommended in No. 4, and manure is used on the following crop, a moderate application of a phosphate fertilizer usually will be sufficient for corn or other crops except tobacco. However, there are cases in which a complete fertilizer may be

* For a graphic comparison of superphosphate and rock phosphate on the Kentucky soil experiment fields, see the Journal of the American Society of Agronomy for June, 1930, Vol. 22, pp. 489-497

more profitable than a phosphate fertilizer. The following tests are suggested: For corn compare (a) 100 to 150 pounds of superphosphate, or its equivalent of other phosphate fertilizer, per acre, in the hill or row with the corn, and (b) 100 to 150 pounds per acre of a complete fertilizer containing not less than 3 percent each of potash and nitrogen and 10 to 12 percent of phosphoric acid. The two fertilizers should be tested side by side for a few years until it is demonstrated which is the better.

A complete fertilizer generally gives corn a better early growth than a phosphate fertilizer, but unless the soil is moderately fertile this advantage may not be maintained. A complete fertilizer is more apt to be profitable on fairly good land than on either poor or very productive soil. The same comparison of fertilizers may be tried on small grain and the clover and grass sown with it, using 300 to 400 pounds of fertilizer an acre.

Instead of a complete fertilizer for the small grain and legume crops an application of a high-grade phosphate-potash fertilizer, such as an 0-10-6 or higher grade, may be drilled in with the grain in comparison with the phosphate fertilizer, using enough to furnish the same amount of phosphoric acid as the phosphate fertilizer. In the spring a part of each treated area may be top-dressed with a nitrogen fertilizer. This plan gives a test of the effectiveness of both nitrogen and potash. Moderate applications of fertilizers, say up to 250 pounds per acre of the ordinary kinds, are generally more effective in the hill or row than broadcast. The larger hill applications should not come in contact with the seed.

It should be kept in mind that the small amount of complete fertilizer commonly used in the hill or row for corn and small grain furnishes only a small part of the needs of the crop for nitrogen and potash, and that, at present prices of crops and fertilizers, the main supply of these elements is best maintained by the production and proper use of legumes and manure. However, the complete fertilizer properly used as a "starter" may be profitable under the conditions already mentioned.

6. *Fertilizers for Tobacco.* Very few soils are so fertile that it will not be profitable to fertilize tobacco grown on them.

at average prices for tobacco and fertilizers. Thru a period of thirteen years it has been found profitable to fertilize tobacco on the Experiment Station farm on soil that has given an average yield of leaf of a little more than 1300 pounds an acre without fertilizer.

As a general recommendation for both White Burley and dark tobacco on the soils represented by these fields, a complete fertilizer of approximately a 1-2-1 ratio is suggested, with a minimum of 4 percent of nitrogen and potash. Some analyses of this ratio are 4-8-4, 6-12-6, 12-24-12, etc. It is not necessary that the proportions conform exactly to these figures. For example, on soils that are very deficient in phosphorus the proportion of phosphoric acid may be increased. If tobacco is grown on sandy soil, the potash figure may be increased. Where it is believed that the soil is well supplied with nitrogen, a fertilizer lower in nitrogen may be used, and if the tobacco does not grow satisfactorily, a side-dressing of soluble nitrogen fertilizer may be applied.

"Muriate of potash" may be used for tobacco in applications not to exceed 50 pounds of the salt per acre, with little if any danger to the quality of the tobacco. (The amount of muriate or sulfate of potash used to furnish the "potash" (K_2O) is approximately double the figure for potash. For example, 600 pounds of 4-8-4 fertilizer with the potash from muriate would contain approximately 50 pounds of muriate of potash.) Where heavier applications of potash are used, part or all of it may be in the sulfate form.

The Experiment Station does not at present have data to warrant making different recommendations for dark tobacco and Burley tobacco grown outside of the highly phosphatic soils of the Bluegrass region.

Fertilizers are more effective when applied in the row or hill. Up to 500 or 600 pounds per acre (4-8-4 or equivalent) may be applied in the row (not hill) if it is well mixed with the soil. One hundred and fifty to 200 pounds may be applied in the hill (for dark tobacco) if well mixed with the soil. Thoro mixing with the soil is important.

The amount of fertilizer to use on tobacco probably can best be judged by the estimated productivity of the soil in

terms of corn yields. For soils that produce 30 to 40 bushels of corn per acre in a good season, 500 to 600 pounds (4-8-4 or equivalent) of the fertilizer is recommended for tobacco; for soils that make 50 to 60 bushels, 400 to 500 pounds. If fertilizers of higher analysis are used, the amount should be reduced proportionately.

If as much as 10 or 12 tons of good manure per acre can be used, a liberal application of a phosphate fertilizer alone may be expected to give excellent results. (See Greenville field.) If less manure than this is used, a complete fertilizer will likely prove more profitable (see Campbellsville and Mayfield fields).

Tobacco should be grown only on well drained soil kept productive by the use of legumes, grass, and manure.

7. *Fertilizing Alfalfa.* Alfalfa used in the hay mixture showed a decided response to potash on the various fields, altho the effect is not so greatly reflected in the total yields. Alfalfa is not only a heavy feeder on potash, but requires a large amount in a short period of growth, and unless the land is liberally manured or potash fertilizer is used a deficiency of this element is very apt to occur. In all seedings of alfalfa it is recommended that a test be made for the need of potash. This may be done by applying muriate of potash at the rate of 200 pounds per acre on a plot that has been limed and fertilized with a phosphate fertilizer. If potash shows beneficial effects, the remainder of the crop may be top-dressed immediately following a cutting.

Alfalfa makes such a heavy draft on the soil that it often needs top dressing with fertilizers unless very large amounts were applied at seeding time. After the stand is two or three years old, or whenever it does not appear vigorous, it is advisable to make a top-dressing test by applying superphosphate (500 pounds per acre) on a small area, and superphosphate and muriate of potash (500 and 200 pounds per acre, respectively) on an adjoining area. If either treatment increases yields sufficiently, the remainder of the field may be treated accordingly. These tests are best made when spring growth begins or immediately after the first cutting of the season.

When alfalfa is sown for the first time on soil that is deficient in nitrogen, a medium application of a soluble nitrogen

fertilizer may be helpful in supporting the crop until inoculation becomes effective. An application supplying 15 to 20 pounds of nitrogen per acre is suggested in connection with other fertilizers.

8. *Top-dressing.* Top-dressing with soluble nitrogen fertilizers is profitable under some conditions on small grain, timothy for hay, bluegrass and orchard grass for seed, and pastures. The prices of crops and fertilizer materials will be a large factor in the profitableness of the practice. The use of nitrogen top-dressings is most likely to be profitable in backward springs and on thin lands, but is not likely to be profitable except on lands well supplied with phosphorus and potassium, either naturally or by application.